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This document presents the methodologies, assumptions and input data used by EPA to promulgate a strategy for the control of sulfur dioxide in the State of Ohio. The document contains explanations of the application of state-of-the-art technology to control strategy development on both a county-by-county and facility-specific basis. The control strategies presented demonstrate attainment of the primary and secondary SO_2 ambient air quality standards and continued maintenance of the standards through 1985. The document contains the EPA consideration of economics and public and corporate comments and suggestions.

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SULFUR DIOXIDE CONTROL FOR THE STATE OF OHIO

VOLUME I FINAL

BY

ENVIRONMENTAL PROTECTION AGENCY
REGION V
AIR PROGRAMS BRANCH
CHICAGO, ILLINOIS 60604

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VOLUME I

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EXECUTIVE SUMMARY

INTRODUCTION

This rulemaking by the United States Environmental Protection Agency (USEPA) to develop a viable control strategy for sulfur dioxide (SO_2) emissions in the State of Ohio has involved the most refined analytical techniques ever employed by the Agency since the inception of the Clean Air Act and in so doing the Agency has gone beyond the requirements of the law. In this rulemaking the USEPA developed SO_2 emission control regulations sufficient to assure the attainment and maintenance of the primary and secondary National Ambient Air Quality Standards (NAAQS), as required under the Clean Air Act, as amended. Ambient air quality standards for SO_2 have been established for annual, 24-hour, and 3-hour time periods of measurement, as illustrated in the following table:

National Ambient Air Quality Standards
For Sulfur Dioxide

Primary Standards:	80 micrograms per cubic meter (annual arithmetic mean)
	365 micrograms per cubic meter (24-hour average not to be exceeded more than once per year)

Secondary Standard: 1300 micrograms per cubic meter (3-hour average not to be exceeded more than once per year)

This rulemaking represents a massive attempt to secure and apply state-of-the-art technology to control strategy development on both a county-by-county and facility-specific basis throughout the entire State, while keeping several key goals in mind.

First, the final control strategy selected for application must demonstrate the attainment of the primary and secondary SO_2 ambient air quality standards throughout the State of Ohio, and do so within the time frame provided in Section 110 of the Clean Air Act, as amended.

Second, the control strategy must demonstrate the continued maintenance of the ambient air quality standards, once achieved. The control strategy contained herein includes an assessment of the impact on ambient air quality due to continued industrial growth and development through 1985.

Third, the developed control strategy must take cognizance of the existence of other critical air pollution control program requirements under the Clean Air Act, most notably the prevention of significant deterioration of the air quality in areas of the State which are presently cleaner than the levels required by the ambient air quality standards. The regulations contained herein include such an assessment in that existing facilities in cleaner areas are examined in terms of their allowable emissions in order to safeguard the applicable air quality increments.

Finally, the selected control strategy must seek to achieve a delicate balance between program requirements with potentially different objectives and emphasis. These programs include the minimization of overcontrol of sources in those areas where emission limitations are determined to be neccessary; the minimization of overall SO_2 emission increases (i.e., the regulation of atmospheric sulfates); the tall stack and supplementary control system (SCS) policies which require the application of all available permanent control measures before dispersion control techniques may be utilized to attain the ambient air quality standards; and the standards of performance for new construction of certain types of facilities (i.e., New Source Performance Standards). That is, while the control strategy must demonstrate as its first concern the attainment and maintenance of the primary ambient air quality standards, it must also demonstrate the attainment and maintenance of the secondary ambient air quality standards within a reasonable time, and both while attempting to strike a balance between other national programs (e.g., energy) to the fullest extent possible.

The final rulemaking included herein has met the above criteria. The regulations will assure the attainment and maintenance of the ambient air quality standards through 1985. The impact of new source performance standards was assessed where applicable. The prevention of significant deterioration, minimization of overcontrol, and adverse cost were addressed to the maximum extent practicable within the framework of the regulatory process. No control requirements are being placed on existing facilities located in areas where no present or potential air pollution problems were found (within the limits of the prevention of significant deterioration increments, where applicable), which would be attributable to those existing facilities. Thus, the overall control strategy maximizes the potential use of presently used fuels wherever possible, while relying upon new source review procedures and non-significant deterioration increments to safeguard the ambient air quality standards in cleaner areas.

The remaining portions of this summary briefly describe the original proposed regulations (including the methodologies, assumptions, and input data used therein); an overview of the many various public comments received regarding the proposal, the USEPA's responses to those comments in arriving at the final regulations; and finally, a detailed summary of the final rulemaking. This latter discussion also provides some overall economic and emission reduction comparisons between the originally proposed regulations and the final regulations.

Summary of the Proposed Regulations

The proposed regulations were published in the Federal Register on November 10, 1975 (40 FR 52410). The project to develop a viable SO_2 control strategy proposal for the State of Ohio was initiated with a careful survey and assessment of all available air pollution dispersion simulation techniques. The purpose and need for the selection of the dispersion models were twofold. First, to complement the existing air quality monitoring data base in assessing air quality levels statewide; and second, to provide for the testing of various emission limitations by predicting potential air quality levels in the future with and without controls applied.

The models which were selected for this rulemaking were the Climatological Dispersion Model (CDM), MAX-24, the Miller Holzworth formula, the Valley Model, and the proportional model. Various modifications were made to the models to provide better applicability to the proposal. Most noteworthy were the modifications to the CDM which provided for the identification of individual sources in terms of their contribution to the overall air pollution concentration at a given receptor. This modification provided for the identification and analysis of critical receptors during strategy development to allow for slight adjustments to the strategy under analysis (in terms of source-specific controls) to more adequately address any identified "hot spots." Another critical addition to the CDM was the development of the Control Strategy Forecasting Program (CSFP) which provided for the application of source specific growth rates and testing of pre-selected alternative emission limitations within identified urban areas. In urban areas where inadequacies in the data base or significant terrain problems caused unacceptable results using the CDM, the proportional modeling techniques were applied. The urban areas in which proportional modeling was applied were Steubenville and Youngstown (proportional modeling plus the CSFP); plus Dayton and Cincinnati (proportional modeling only). In all urban areas, the short-term air quality standards were assessed through facility-specific analyses using the MAX-24 dispersion model.

The data base for the proposed regulations was compiled from many sources. Emission data were initially gathered from the National Emission Data System (NEDS), the Ohio EPA, and local air pollution control agencies for the years 1973 and 1974. In addition, the USEPA contacted approximately 150 facilities directly, using the mechanism provided under Section 114 of the Clean Air Act, to collect more specific emission data and facility operating parameters. The air quality data were derived initially from the Storage and Retrieval of Aerometric Data (SAROAD) system for the base years 1973 and 1974. All air quality data were subjected to validity and quality assurance checks based upon USEPA evaluations of State and local air pollution control agency data handling procedures. Meteorological data were obtained for 1964 for every major urban area in the State, through the National Climatic Center (NCC). The data were compared to more recent meteorological data in an attempt to identify any significant trends or patterns which may affect the dispersion model predictions. However, no such patterns were found.

The methodologies selected for the proposed regulations were developed to provide the optimal combination of available dispersion simulation models and the associated data base. For the identified urban areas, the application of the CDM and CSFP coupled with the facility-specific MAX-24 analysis provided the most accurate assessment possible at that time of the impact of control strategy development versus the annual and short-term SO_2 ambient air quality standards. The application of proportional modeling techniques, to urban areas where the CDM could not be applied, was considered to be appropriate since the available data base, coupled with the facility-specific MAX-24, provided a level of analysis that was as accurate as possible and still employed state-of-the-art technology to the most practicable extent. The MAX-24/Miller-Holzworth analysis provided an acceptable level of refinement in control strategy development for application to the remaining counties in the State. That is, the technique provided for a reasonable assessment of control strategy needs on a county-specific basis, employing the available data base to the optimal extent practicable at that time. The resultant identification of the need for absolutely no controls on existing facilities in thirty-two of the eighty-eight counties in the State stood as evidence of the reasonableness of this technique for control strategy development.

During the course of the development of the proposed control strategy, several key criteria were employed for the first time. First, in the analysis of the impact of specific major facilities on the short-term (24-hour) SO_2 air quality standard, some assessment had to be made regarding the potential impact of other anthropogenic (i.e., man-made) pollution on the receptor in question. The technique employed was to seek out an approximate worst case occurrence where such data were available, and to apply the conclusions of such an analysis to areas where the base data was not available. For the proposal, air quality data were available in the vicinity of three power plants, which included wind speed and directional parameters. The resultant appropriate second highest 24-hour values derived for the three plants, when the monitoring site was approximately upwind from the plant and consequently not affected by the plume from the stack, were nearly equivalent to the value of 100 ug/m³. Thus, given the different geographic locale for each of the plants and the resultant similarity of the results, the value of 100 ug/m³ was selected as a best approximation of anthropogenic "background" air quality levels throughout the State.

Another area of special note in the development of the proposed regulations involved the assessment of the control strategy viability with respect to the short-term air quality standards within an urban area. At the time of the proposal, there were no operational macroscale air pollutant dispersion simulation models available which were capable of a direct assessment of the short-term SO_2 standards within an urban environment. Therefore, instead of attempting to mathematically "tie" the available short-term facility-specific models (i.e., MAX-24) to the available annual macroscale urban diffusion model (i.e., CDM), a better technique was to simply examine a strategy with respect to the annual standard using the CDM first; and then examine the impact of that same strategy with respect to the most critical single sources in the urban area and the short-term standards using both the MAX-24 program and the short-term background value of 100 ug/m³. This technique provided for the most accurate assessment of both the annual and short-term SO_2 air quality standards without altering the basic mathematics or underlying assumptions of the two models, without trying to tie incompatible meteorological data sets together (i.e., the 5-year average meteorological data set used in CDM, and the hourly 1964 data set used in MAX-24).

A third area of special note in the development of the proposed regulations pertained to the technique applied to control strategy development for specific facilities. Comments were received during the development of the proposal regarding the need to assess average 24-hour plant operating conditions or to use some assessment of actual plant operating conditions for a specific day in a specific year. However, the Agency stated at that time that such was neither the intention nor the goal of the control strategy development. As specified by the Clean Air Act and the short-term national ambient air quality standards for SO_2, the strategy must be developed about a potential once-a-year excursion of the air quality standard. In essence, this is an approximation of a near worst-case occurrence between potential plant operating parameters and meteorological conditions. Thus, for the purposes of designing a control strategy to guard against an approximate worst-case occurrence, it was necessary to analyze the design operation conditions of the facility itself, and to assess the impact of such operation when coupled with the worst observed base year's meteorological conditions that could give rise to a short-term air quality standard violation. The control strategy was therefore designed by matching plant design capacity to this hourly meteorological data for the entire year, in order to seek out the frequency and magnitude of the 24-hour concentrations when coupled with background air quality. By the use of such technique, however, it was not intended that any given facility be expected to operate at design rates for a full year. Instead, the strategy was aimed at the potential for plant operation at or near design rates at any given time and the result of such operation if worst meteorological conditions exist at the same time.

A final area of special note regarding the proposed regulations involves the assessment of the secondary (3-hour) SO_2 ambient air quality standard. Existing technology at that time limited the capability of the Agency to analyze the 3-hour standard on a facility-specific basis. To address the secondary standard in the proposed regulations, each of the documented 3-hour air quality standard violations was examined on a case-by-case basis to determine the required emission control based upon proportional modeling techniques. However, it was found that, in each of the instances where documented 3-hour violations had occurred, the annual standard and/or the 24-hour standard violations required a greater amount of control and therefore represented the limiting case. This being the case, the control strategy was developed based upon the county-specific analysis of the primary standards. It was determined that such an approach would be adequate to safeguard the secondary standards for the period of consideration.

The resulting set of proposed regulations, published in the Federal Register on November 10, 1975, was a county-specific regulation with a flat rate (pounds SO_2/MBTU) proposed for non-urbanized counties and a "sliding-scale" proposed for urban counties. For each of the rural counties, the flat rate emission limitation was based upon the control required for a worst case facility or group of facilities, with that emission limitation then being applicable to the entire county in which the facility was located. This was termed the "example facility" approach to control strategy development. Each of the urban strategies was the result of a series of tests of pre-selected emission limitations with the finally selected strategy being the one which demonstrated the necessary amount of overall emission reduction with the least amount of overcontrol. In addition, all counties were subject to a general process regulation (allowable SO_2 emissions in pounds/hour). Finally, specific emission limitations were applied to petroleum refineries, primary zinc plants, sulfuric acid plants, coke ovens, and sulfur recovery plants. For the most part, the proposed regulations did not address the costs of control in detail to meet the proposed limits, as a detailed facility-specific consideration of costs was not deemed necessary under the requirements of the Clean Air Act.

Summary of Public Comments Received

One of the most significant and time-consuming concerns of the Agency in finalizing the SO_2 control strategy for the State of Ohio was compliance with the Administrative Procedures Act provision (APA Section 553) relating to the consideration of public comment in the rulemaking process. It has been the intent of the Agency to adopt regulations that will not only be substantively adequate to attain and maintain the ambient air quality standards for SO_2 in Ohio, but to assure that they are adopted in accordance with all applicable procedural requirements.

A large volume of material was received and reviewed including general citizen support, highly detailed independent technical analyses, emissions data, air quality data, technological and economic feasibility commentary, and comments on administrative, procedural and legal aspects of the action. Each document submitted (and the record of the public hearings) was reviewed and considered in order to identify:

1. Data potentially useful as input to the dispersion modeling methodologies applied in the county-by-county reevaluation of the proposed control strategy.

2. Suggestions pertaining to the structure of the regulations and the technical adequacy of the methodologies (and their inherent assumptions) utilized in developing the regulations.

3. Comments pertaining to numerous but important peripheral issues related to compliance schedules, technological and economic feasibility, stack height increases, atmospheric sulfates, air quality maintenance requirements, and others.

For discussion purposes, the comments received may generally be grouped into seven various categories: Miscellaneous comments; technological feasibility comments; comments regarding the specific proposed regulations; compliance schedule comments; comments on the aspect of ambient air quality maintenance and associated growth projections; comments regarding the dispersion modeling and analytical methodologies employed; and comments pertaining to the economic feasibility of the proposed regulations. Each issue has been addressed thoroughly in the Technical Support Document and is incorporated by reference herein. A summary of the major issues raised, along with the Agency's responses, follows:

1. Miscellaneous Comments

A number of commenters pointed out that the regulations would permit increases in SO_2 emissions in certain areas of Ohio or for particular point sources, contrary to EPA policy on atmospheric sulfates. Related comments noted that the EPA technical analysis took no account of TSP/SO_2 interaction, atmospheric sulfates or sulfuric acid mist. However, the Agency's promulgated regulations meet the requirements of Section 110 of the Clean Air Act in providing for attainment and maintenance of the NAAQS for SO_2. This rulemaking is also consistent with EPA's sulfates policy (Position Paper on Regulation of Atmospheric Sulfates; September 1975). The overall impact of these regulations will be to reduce SO_2 emissions. Although some limited increases will be permitted at a few sources, the sulfate loading in the atmosphere generally will be decreased substantially.

Some commenters suggested that the Agency allow stack height increases and supplementary control systems (SCS) as general means of meeting the SO_2 ambient air quality standards. The arguments made in favor of such a strategy are generally economic in nature. However, the Agency's policy regarding use of dispersion dependent technology as the primary means of achieving the ambient air quality standard is set forth in detail in the "Stack Height Increase Guideline" (41 FR 7450), published February 18, 1976. The policy, which is based directly on several court decisions holds that dispersion dependent technology can be used on a limited basis only after constant emission limitations have been employed to the maximum extent achievable. Detailed source specific technical studies are required to determine if a facility meets the tests before stack height increases may be allowed. EPA has reviewed the comments and statements submitted in response to this rulemaking and concluded, based on this record, that no source currently qualifies for an exception to these final emission limitations based on stack height increase. However, EPA will consider a petition for a revision to these final requirements should a source be able to demonstrate the infeasibility of these requirements.

It was alleged that the EPA proposal was procedurally deficient in that an Inflation Impact Statement (IIS) was not prepared pursuant to Executive Order 11821 (39 FR 41501, November 29, 1974), prior to proposal and made publicly available. However, the Agency's response to such comments was that prior to the proposal of the SO_2 control plan for Ohio, the Agency had not yet finalized its guidelines designating those regulatory actions which would be subject to the President's order. There were strong indications that regulatory actions affecting only one State would not be subject to IIS requirements. Accordingly, no IIS was prepared at the time of proposal. Moreover, the Agency is in accord with the reasoning of the 8th Circuit U.S. Court of Appeals (see Independent Meat Packers Assoc. vs. Butz, 514 F2d 1119 (1975)) in that the Inflation Impact Statement is not a necessary part of the rulemaking process. However, the Agency, as a useful aid in its own internal decision-making process, found it valuable to prepare an inflationary impact statement which will be available to the general public shortly after promulgation.

Several comments were received which stated that the proposal was deficient in that it did not specifically provide for various resource elements required under Section 110(a)(2) of the Clean Air Act, such as personnel, funding, reports, ambient monitoring and new source review procedures. However, Section 110(c) requires the Administrator to "promptly prepare and publish proposed regulations setting forth an implementation . . ." and later on to ". . . promulgate any such regulations." Thus, when the USEPA engaged in substitute rulemaking because of State plan deficiencies, its correcting action is limited to regulatory actions. Except for new source review procedures, all of the above-mentioned elements are non-regulatory and therefore not subject to the 110(c) mandate. The State's procedures for new source review were approved on April 15, 1974, and remain effective for purposes of determining compliance with SO_2 requirements.

Several comments were received which stated that some companies would have to scrap plans for compliance with particulate matter emission limitations if SO_2 regulations are promulgated. One commenter urged the Agency to proceed quickly with promulgation of the SO_2 regulations so that compliance with particulate matter regulations can proceed effectively. The Agency's response to the argument concerning the interdependence of SO_2 and particulate matter control has consistently been to handle claims of interdependence on a case-by-case basis through enforcement mechanisms. Extension of the Ohio attainment date for particulate standards as proposed by EPA on January 14, 1976 (40 FR 2099), should alleviate some problem situations. Finalization of this extension is expected shortly.

Other miscellaneous comments were received which addressed such issues as potential economic savings by allowing for infrequent violations of the short-term SO_2 air quality standards; regulation relief to "insignificant" SO_2 sources; the validity of the SO_2 ambient air quality standards; the utilization of a SO_2 emission tax; and comments regarding the Agency's administrative procedures for public participation in the rulemaking process.

2. Technical Feasibility Comments

Many comments were received concerning the status of flue gas desulfurization (FGD) for use in fossil fuel-fired steam generating units which ranged from very positive to very negative. On the positive side statements were received to the effect that the technology is well demonstrated and reliable when given competent attention; that the costs of FGD are viable when compared to other compliance alternatives; and that the pollution control industry has the capacity to meet national FGD needs projected through the early 1980s. On the negative side, some commenters maintained that long-term demonstration of reliable operation of FGD on a typical coal fired baseload power plant has not yet been accomplished; that the FGD reduces utility system reliability and imposes an unacceptable energy penalty on the system; that technology has not been demonstrated to be feasible for application to industrial boilers or small utilities, or for use with high sulfur coal; that the problem of disposal of scrubber sludge has not been solved in an acceptable manner; or that site specific considerations preclude FGD installation at a particular facility.

Comments were also received regarding the technological feasibility of the regulations applying to coke ovens, sulfuric acid manufacturing plants, sulfur recovery plants, process equipment and petroleum refineries. On the positive side one manufacturer of fuel and flue gas desulfurization systems said that the regulations as proposed for coke oven gas, sulfuric acid plants and sulfur recovery plants are achievable by current proven technology. Also, certain air pollution control agencies are currently enforcing regulations similar to or more stringent than the one proposed for coke ovens in Ohio. On the negative side, several industries alluded to particular physical constraints at their facilities or the high costs which would have to be incurred in order to achieve compliance.

However, the USEPA believes that the evidence concerning the issue of technical feasibility is conclusive, and that the proposed regulations were generally feasible at a great number of sources through retrofitted controls or fuel switching. The promulgated regulations are somewhat different from the proposed regulations in terms of their stringency. The final regulations tend to be slightly less restrictive on an overall basis than the proposed requirements. These changes resulted from the modeling reevaluation which incorporated consideration of data provided during the public comment period. Also, the regulations for petroleum refineries were changed in form, in response to public comments, to more substantially reflect actual operations at refineries. Nevertheless, EPA has addressed in detail the technological feasibility of the promulgated regulations in the Technical Support Document (TSD) to this rulemaking.

In addition, EPA contractors conducted inspections under the authority of Section 114 of the Clean Air Act of facilities exemplifying various site-specific considerations which might impede the implementation of a compliance program. Special reports were then prepared outlining potential alternative emission control programs and describing in detail the most probable approach to compliance with the proposed regulations. Nine industrial facilities and eleven electric utility operations were inspected. Final reports are available for review at the Region V EPA office. The studies generally indicate that careful planning and consideration of alternative compliance programs can usually overcome most site-specific physical constraints.

3. Comments Regarding the Specific Proposed Regulations

Considerable public comment was received regarding the omission in the proposed plans of specific regulations applicable to new sources. However, the Agency has pointed out the fact that regulations applicable to all significant new sources have already been promulgated on a State and national basis. A State permit to allow the construction of new sources or the modification of existing sources cannot be issued to new sources, subject to certain exemptions, until the State determines that operation of the new source (or modified source) would not interfere with the attainment or maintenance of the Ohio air quality standards. In addition, certain new facilities are subject to the New Source Performance Standards (NSPS) and/or the Federal Regulations (40 CFR 52.21) for the Prevention of Significant Air Quality Deterioration (PSD). Sources covered by the PSD regulations are currently required to obtain a permit to construct from the Region V office of the EPA. The EPA has therefore concluded that the existing mechanism for the review of new or modified sources is adequate to protect both the NAAQS and the significant deterioration increments.

Another key subject for which public comment was solicited concerned the topic of equipment malfunctions. Specifically, the Agency requested information from sources covered by the proposal regarding the kind of control equipment they plan to install, why such equipment may malfunction, circumstances that would necessitate continued source operation during the period of malfunction, alternative methods of controlling emissions to comply with regulations during such periods, and methods of documenting control equipment downtime. Little response was received to this solicitation.

Therefore, the Agency has found no basis in the record to revise the determination that violations of the emission limitations that occur during periods of equipment malfunction can be resolved through enforcement discretion. It should be noted that existing State regulations require that certain reporting and correctional steps be taken by source operators during periods of malfunction or scheduled maintenance.

Considerable comment, both pro and con, was generated on the county-by-county approach utilized in developing the proposed regulations. Such commentators expressed the opinion that regulations should be in effect only where violations of the NAAQS are well documented through ambient monitoring and should apply only to those sources found to be primarily responsible for the violations. A number of comments reflected a desire for uniformity in requirements throughout the State or throughout regions within the State, pointing out that similar facilities which may be competitors could be subject to vastly different requirements depending upon their geographic locations. At least one comment suggested regulations on an Air Quality Control Region (AQCR) basis.

The Agency has pointed out on a number of occasions that the purpose of this rulemaking is to provide for attainment and maintenance of the SO_2 NAAQS as required by Section 110 of the Clean Air Act. The authority to implement more stringent requirements is reserved solely to the States, by Section 116 of the Act. The Agency's modeling results clearly show that the relationship between SO_2 emission rates and resulting ambient air quality varies greatly across the State. Therefore, the concept of Statewide or "AQCR-wide" regulations is ruled out in Ohio due to the impossibility of satisfying the Clean Air Act requirement to set emission limitations that attain and maintain the NAAQS. The Agency determined that the best approach in the final rulemaking was to develop a flat-rate or sliding-scale regulation on a county basis while regulating certain sources on an individual basis. The individual analysis of each county dictated the final format for the county.

Another subject of concern pertained to the lack of regulations in the proposal for existing sources in thirty-two counties. However, the Agency has determined that existing sources in those counties, with operations projected to maximum capacity, pose no threat to the SO_2 standards; and that new source review procedures are adequate to protect the SO_2 standards and the Prevention of Significant Deterioration (PSD) increments in the future. In the promulgated regulations, thirty-three counties are unregulated for the rationale presented in the TSD to the proposed rulemaking.

The Agency also received a number of comments objecting to the application of the regulations to individual emission points as opposed to facility-wide regulations. A facility-wide regulation, it was stated, would enable the manager of a facility to decide the most economic and practical way to reduce emissions from the facility. However, other commenters suggested having unit-by-unit regulations based on capacity, fuel use, and stack height, plus separate requirements for each manufacturing process within a facility.

The Agency's response to these concerns is that, as in the proposal, the final regulations generally require controlling emissions to specific limits at individual emission points (i.e., stack-by-stack). A stack-by-stack approach is necessary to assure achievement of the standards without placing overly restrictive requirements on individual facilities. This conclusion is based on the fact that different stacks, for a given emission rate, have varying impacts on ambient air quality. The stack-by-stack approach leads to regulations which assure standards achievement, yet allows facility managers flexibility to decide the most economical and practical way to control all units connected to a common stack. As an improvement on this approach, in consideration of the public comments, the Agency has found it feasible, in the case of certain isolated facilities, to allow even greater flexibility to managers in the selection of control programs, while still assuring standards achievement. This is accomplished in the final regulations by setting forth equation(s) that establish a relationship for the emission rate (under worst case conditions) at each individual stack and the ambient air quality impact of those emissions at the location of critical receptors. The facility manager may choose any combination of emission limitations on a stack-by-stack basis such that the equation(s) is satisfied. This flexibility assures attainment and maintenance of the standards while giving the facility manager optional flexibility in selecting least costs controls.

Other comments received regarding the specific proposed emission limitations addressed such subjects as the use of a sliding-scale emission limitation based on source size; the need to promulgate a plan designed to achieve the ambient air quality standards established in Ohio; the need for the regulations to control emissions from Federal and State facilities; plus numerous comments regarding the specific emission limitation proposed for either a certain county or a specified facility class. The detailed response to each of these issues is contained in the Technical Support Document to this rulemaking.

4. Compliance Schedule Comments

The various compliance schedules proposed in the control plan generated several comments. Some expressed concern that a number of facilities might be allowed more time for compliance than they actually need. Others maintained that the schedules are too short to be met by most facilities. The three-year compliance schedule for installation of FGD systems elicited substantial public comment. Some utilities submitted statements that the schedule could not be met at specific plants. One organization representing vendors of pollution control equipment pointed out that the three-year schedule would be especially hard to meet for utilities with several plants each containing multiple units requiring FGD. Interest was also expressed in the phase-in scheduling of various FGD systems, to coordinate the times that generating capacity will be removed from service to install the necessary equipment.

The Agency's response to these concerns was that under Section 110 of the Clean Air Act, the implementation plan must provide for attainment of the primary standard within three years of promulgation of the plan, and attainment of the secondary standard within a reasonable time thereafter. With some exceptions, the primary standard has proven to be the more restrictive standard in Ohio. Therefore, none of the promulgated compliance schedules extends beyond three years. The promulgated compliance schedules, although rigorous, are feasible and can be met by most facilities which proceed with compliance plans without delay. Nevertheless, it is recognized that, as a practical matter, some sources will prove to be exceptions in that: 1) Expeditious action on the part of the source owners may enable compliance over a shorter time frame than that provided by the promulgated compliance schedules; or 2) compliance within the time frame set by the promulgated schedules may prove physically impossible. However, such exceptional cases are best identified through the enforcement process due to the detailed source specific factors which must be evaluated. The regulations pertaining to compliance schedules afford the flexibility to adjust compliance schedules on a case-by-case basis, if necessary.

A great deal of comment was received on the requirement that sources electing to comply by using low sulfur fuel enter contracts for a ten-year supply of fuel with the appropriate characteristics to enable compliance with the proposed regulations. Many of those commenting found such a requirement to be unnecessary, unrealistic, and burdensome to owners and operators of industrial boilers and small coal consumers. Others maintained that flexibility in selecting fuel suppliers is essential in attaining good quality coal. This contract requirement has been deleted. Nevertheless, the regulation requires sources to submit information regarding short-term commitments to fuel supplies. Considering the structure of the coal industry, this improves the probability that sources will be able to obtain supplies of complying coal in the long run.

5. Air Quality Maintenance Comments

Most commenters agreed that the Agency's rationale for the five-year growth projections utilized in developing the proposed regulations was not valid. Others stated that industry should have confidence that investment in pollution control programs should be adequate for at least ten years.

In the proposal EPA contended that maintenance considerations were best addressed through maximum utilization of local input through on-going regional planning processes (generally Federally funded metropolitan planning organizations) with overall coordination by the State of Ohio. In response to the public comment received, the Agency has utilized ten-year growth projections in developing the promulgated regulations.

This is consistent with the minimum requirement of the regulations for air quality maintenance (40 CFR 51; subpart D).

Several commenters also criticized a number of technical assumptions behind the projections of future emissions utilized in developing the proposed regulations. Commenters stated that the parameters "value added," "population," and "employment" were poor indicators to use to forecast future emissions, due to two implicit assumptions: 1) That technology will remain constant over the projection years; and 2) that emissions are proportional to output. It was also pointed out that wide variety of industries comprise the industrial categories represented by two-digit Standard Industrial Classification (SIC) codes and that the EPA methodology assumed that the composition of the industrial categories would not change over the projection years. Lastly, it was pointed out that the data used to develop the growth projections did not take into consideration the "oil boycott" years, and asked that the Agency provide further justification for the selection of the data base years.

The Technical Support Document to this rulemaking describes the growth projection methodology in detail and addresses the criticisms.

6. Dispersion Modeling and Methodology Comments

One of the most frequent comments received concerned the Agency's use of dispersion modeling to predict air quality for areas where no ambient monitoring data exists or where existing monitoring data indicated no observed violations of the ambient air quality standards. The comments stated that the Agency should not promulgate regulations for sources in such areas, since the existing air quality data indicated that the addition of control regulations is not necessary to assure attainment and maintenance of the air quality standards.

However, the Agency has explained the need to use dispersion modeling mehtodologies in the development of control strategies as follows: First, monitored ambient air quality data represents only a sample of actual air quality as a function of both site location and measuring time. Therefore, dispersion models may be utilized to complement existing ambient air monitoring data by estimating ambient concentrations in areas where no monitoring data exists. Second, the use of dispersion models is necessary to protect air quality under potential future source operating and growth conditions. At present, dispersion modeling is the best method available to predict future air quality concentrations and concomitantly the need for control. In an effort to reliably assure attainment and maintenance of the ambient air quality standards (or protection of the PSD increments), the Agency must regulate sources where valid modeling results project future air quality standard or PSD increment violations. In addition, the use of dispersion models in control strategy development is supported in the record by comments received from utility, industrial and control agency representatives.

Another significant area of concern pertained to the dispersion modeling assumption of simultaneous occurrence of a number of "worst case conditions" in addressing control strategy development for the 24-hour and 3-hour SO_2 standards. Arguments were presented that the assumption is unrealistic and that it results in regulations which are more stringent than necessary to assure the attainment and maintenance of the ambient air quality standards. Most notable was the concern expressed over the analysis of facilities at the "design load" or full capacity operating level. The suggested alternative was the use of actual facility operating rates (i.e., "nominal load" data) for control strategy development rather than design load data.

The motivation for the use of this approach would seem to be an attempt to simulate the actual plant operating characteristics and the interaction between these operations and meteorological conditions. However, although this approach may be appropriate for an historical examination of the air quality impact of a particular plant, it presents some significant problems if used to determine emission limits. The most critical implication of this suggestion is that the particular combination of plant operating characteristics and meteorological conditions is fixed in time. This is obviously not the case.

The Agency has argued that the use of the emission rate associated with maximum load operations in control strategy development provides several positive features. If it is assumed that the meteorological data for a given calendar year are representative of the range of meteorological regimes in the area, then meteorological data from only one year are required to determine the air quality impact of the facility. This provides, perhaps, the strongest motivation for using maximum load modeling procedures. With this assumption the uncertainties in the joint probabilities of meteorological conditions and plant operation arising from the use of only one year's meteorological data have been avoided.

Other advantages associated with the maximum load approach include: 1) Enforceability -- it avoids the enforcement problem of guaranteeing that the plant operates below some specified level; 2) it protects against the impact of the plant during maximum load operations; 3) it avoids problems encountered whenever plant operation data are missing, due to equipment malfunctions, or plant operations; and 4) it avoids technical problems of determining the appropriate emissions rate and the appropriate stack gas temperature and flow rate associated with the varying levels of plant operation. Actual tests by the Agency in which the results of the maximum load approach were compared to those of the nominal load approach for several facilities indicated that the former approach does not greatly overestimate predicted air quality concentrations. Therefore, for regulatory purposes, the use of design, or maximum load operating rates in control strategy development offers a reasonable, consistent, and conceptually sound approach.

Another key topic of concern pertained to the use of a 100 ug/m^3 concentration as the 24-hour anthropogenic (i.e., man-made) background contribution for most rural areas. This value was determined by the Agency utilizing detailed ambient air monitoring data which was available for only three counties. The value was criticized as being unrealistically high for many counties, and it was recommended that the Agency carefully reevaluate the rural 24-hour background. As a result of these criticisms, the Agency undertook an extensive reevaluation of the 24-hour ambient background estimates. Data submitted during the public comment period was used in conjunction with previously available data to provide a basis for determining background concentrations on a county-specific basis. Several methodologies were employed to offset limited data availability in some areas.

A number of commenters questioned the general validity of the MAX-24 single-source methodology. Several questioned the Agency's method of adjusting physical stack height to account for terrain features as well as the applicability of the MAX-24 dispersion model in urban areas. In addition, a number of commenters stated that it was inappropriate to use the maximum concentration predicted by the model, instead of the appropriate second-maximum value, to develop emission limits.

The methodologies utilized by the Agency in the preparation of this final rulemaking obviate these objections. The regulations contained herein are based upon the projected impact of sources at receptor locations whose actual elevations were calculated using readings from U.S. Geological Survey (USGS) maps. Specific stack height adjustments were examined. The MAX-24 model had been used in urban areas in the proposal as a cross-check for emission limits developed based on the annual CDM urban model. The MAX-24 program utilized available dispersion coefficients which were more suitable to rural areas. However, for the final rulemaking, a 24-hour model (i.e., RAM) was specifically developed as an urban model utilizing appropriate urban dispersion parameters for control strategy development. This model is more fully discussed in the Technical Support Document to this rulemaking. In response to the third objection, the Agency reprogrammed the MAX-24 single-source model to predict second maximum concentrations for control strategy development. In all cases where the 24-hour standard was determined to be critical, the promulgated regulations were based on the appropriate second-maximum concentration consistent with Agency policy regarding interpretation of the 24-hour standard. The RAM short-term urban model was also utilized to analyze the secondary (3-hour) air quality standard.

Other technical comments received on the subject of dispersion modeling and control strategy development methodologies pertained to such issues as a dispersion model validation/calibration; dispersion model input data; SO_2 half-life estimates; Pasquill-Gifford and Turner dispersion coefficients; "Lake-Breeze" effects on Gaussian plume assumptions; and the use of proportional modeling (i.e., "rollback") for emission limitation development. These issues are discussed at length in the Technical Support Document to this rulemaking.

7. Economic Feasibility Comments

A large number of commenters addressed in one way or another the costs of compliance with the proposed regulations and the potential economic impacts associated with those costs. The submitted comments covered a wide variety of topics including potential loss of jobs, potential gain of jobs, plant closing, real economic growth in the pollution control industry, unfair burden on large sources vs. small sources, utility rate increases, product price increases, capital and/or other product supply shortages, reduced medical expenses, reduction in pollution damage to crops, animals and structures (i.e., welfare effects) and more.

At least three important conclusions related to economics can be drawn from the information appearing in the public record.

1) The public and the regulated industries have expressed a general willingness to share the burden of costs associated with any regulations which are shown to be necessary to protect the public health and welfare (i.e., the SO_2 NAAQS).

2) Both favorable and unfavorable economic effects result from the implication of pollution control regulations.

3) For each individual source, the technological feasibility of implementing a compliance program to meet a specific emission limit is directly related to its economic feasibility at the source. It is important to clarify the extent of the Agency's obligations under Section 110 of the Clean Air Act regarding the need to assess economic feasibility in control strategy development. The major objective of the Clean Air Act is the attainment and maintenance of the ambient air quality standards within a time frame specified by the Act. The principal criteria, therefore, utilized by the Agency in developing the regulations for promulgation under Section 110 was their effectiveness in assuring attainment and maintenance of the standards through the emission limitations and reductions which will result from their implementation.

The legislative history of the Act suggests that the cost of reducing emissions was not to be considered an impediment to achieving the ambient air quality standards (Sec. 116 Cong. Rec. 32901). This was recently confirmed by the decision of the Supreme Court of the United States (Union Electric Co. vs. Environmental Protection Agency et al, (No. 74-1542)), which affirmed that the USEPA, in approving implementation plans developed by the States, must limit its consideration to the factors enumerated in Section 110, which factors do not include economic considerations.

In response to the public's concern over potential adverse economic impacts of the proposal, and because the Agency firmly believes that environmental objectives should be accomplished with as little adverse economic impact as practical, the Agency utilized methodologies in developing the promulgation which are considerably more detailed than the proposal's methodologies. In employing the methodologies, the Agency minimized adverse economic impact to the maximum extent practical by ensuring that the promulgated regulations are no more stringent than necessary to assure attainment and maintenance of the standards. In addition, the methodologies utilized in the development of the final control strategy provided for the evaluation of required emission reductions at individual sources in terms of their impact on ambient air quality and the capability of current proven control technology.

As a result of the Agency's revised methodology, few sources will be challenged by the "technology forcing" aspects of the Clean Air Act since the promulgated emission limitations have been demonstrated to be achievable with current proven technology on sources similar to those being regulated in Ohio. The fact that similar emission limitations have been achieved elsewhere on retrofitted sources attests to the overall feasibility of the promulgation.

Summary of the Final Rulemaking

Generally, while not quite as stringent as the proposed regulations on an overall basis, the final regulations are much more specific as they relate to the various facilities in Ohio. Approximately 100 industrial facilities and 40 utilities are specifically identified in an effort to "custom fit" the regulations to the varying needs of the State. No regulations are being promulgated for 33 rural counties in the State. In other rural counties, emission limits are being placed only upon a specified group of problem sources with no regulation applied to other facilities in those counties. This represents a departure from the "example facility" approach utilized in the development of the proposed regulations. The following types of emission limitations are being promulgated: General fuel combustion regulations (expressed as pounds SO_2 per million BTU actual heat input); a general process weight rate limitation (expressed as pounds SO_2 per ton of process weight); a coke oven gas limitation (expressed as grains H_2S per 100 dry standard cubic foot of coke oven gas); a sulfuric acid plant flat weight limit on weight of product produced (expressed as pounds SO_2 per ton of 100% acid produced); a sulfur recovery flat weight limit on weight of product produced (expressed as pounds of sulfur per 1000 pounds of sulfur processed); petroleum refinery catalytic cracking unit limitation (expressed as pounds of SO_2 per 1000 pounds of charging stock); and petroleum refinery off-gas combustion limitation (expressed as grains of H_2S per 100 dry standard cubic feet of oil refinery gas). Depending upon the air quality problem associated with the quality of fuel being utilized and the configuration of sources in a particular area, the general fuel combustion limitation may be either independent of facility size (i.e., 'a flat rate'), or may increase in stringency (to some lower limit) as function of facility size (i.e., a 'sliding scale').

In addition to the above, many major fuel combustion facilities that are isolated from interaction with other sources have been provided with emission control "options." Under this concept, the facility owner is presented with the option of choosing (within a specified period of time) between a single uniform emission limitation (expressed in pounds SO_2 per million BTU heat input) applicable to all stacks, or a series of emission limitations that allow for control variability between stacks. Such an approach represents a significant step toward assuring the attainment and maintenance of the ambient air quality standards while providing a substantial amount of flexibility to the facility owners in achieving the required emission reductions. The control "option" concept could not be provided to all facilities, however, as pollutant plume interaction necessitates a fixed emission limitation for all affected facilities wherever such interaction is found to occur (such as most urban areas). The final emissions limitations for all rural (i.e., "non-urban") areas are listed in Table 1.

With respect to urban areas, the following areas have been identified for both general and facility-specific emission limitations: Cuyahoga County (including the City of Cleveland); Lake County (including portions of the Cleveland Metropolitan Area); Lorain County (including portions of the Cleveland Metropolitan Area); Hamilton County (including the City of Cincinnati); Franklin County (including the City of Columbus); Stark County (including the City of Canton); Mahoning and Trumbull Counties (including the Youngstown Metropolitan Area); Montgomery County (including the City of Dayton); Summit County (including the City of Akron); Lucas and Wood Counties (including the City of Toledo); plus Jefferson and Belmont Counties (including the Steubenville Metropolitan Area). All of the urban areas contain a general fuel combustion emission limitation (expressed as pounds SO_2 per million BTU heat input). Each of the areas contains a general and/or facility-specific process regulation (expressed as pounds SO_2 per ton of process weight). The specific final emission limitations for all urban areas are listed in Table 2.

It should be noted that, as discussed earlier, none of the finally selected emission limitations was the result of a "preselected" control strategy. Instead, each emission limitation -- either for the urban or rural situation -- was specifically developed for each particular region based upon the sizes and air pollution contribuitons of the various facilities in each area. The result of this approach was a control strategy tailored to the specific needs of each particular area.

OVERALL ECONOMIC AND ENVIRONMENTAL IMPACT

The overall total investment cost to meet the final emission limitations included in this rulemaking is estimated to be approximately $500 million. The overall total investment cost associated with the previously proposed regulations was estimated to be approximately $1.23 billion. The annual cost associated with the final rulemaking is expected to be approximately $181 million, compared to the estimate of $379 million for the proposal. The detailed discussion of the derivation of those and other associated cost data is contained in the Inflationary Impact Statement to this rulemaking.

With respect to the overall environmental impact of these regulations, it should be noted that there are currently widespread non-attainment problems for sulfur dioxide in the State of Ohio. These regulations, when fully implemented, will result in the attainment and maintenance of the sulfur dioxide ambient air quality standards through 1985. The total sulfur dioxide emissions will need to be reduced by approximately 2,077,347 tons per year. The estimate represents a 31 percent reduction from the current emissions.

Total Unregulated	6,695,496	TPY
Regulated	4,618,149	TPY

TABLE I - NON-URBAN COUNTIES REGULATION SUMMARY

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Adams	Dayton Power & Light			Optional compliance equation
	Stuart Plant	3.16		
Allen	Ford Motor Company	3.40		Steam generation
	Lima State Hospital	5.39		Steam generation
	Vistron Corporation	1.27		Steam generation
	Standard Oil Company			
	Claus Unit		100.00 lbs. SO_2/1000 lbs. of sulfur	
	Catalytic Cracker		.30 lbs. SO_2/1000 lbs. of petroleum products	
	Trolumen Unit		11.00 lbs. SO_2/ton of production	
	Iso Stabilerzers & Split Heaters (B002)		.71 lbs. SO_2/MBTU input	
	Vac I Heaters		.21 lbs. SO_2/MBTU input	
	All other units (Boilers & process heaters)		.13 lbs. SO_2/MBTU input	
Ashland				Not regulated
Ashtabula	New Jersey Zinc Co.	1.50 (oil)		Steam generation
	Cleveland Electric Illuminating -			Steam generation
	Ashtabula Power Plant			
	Stacks 1, 2, 3	2.40		
	Stack 4	9.10		
	Stack 5	8.20		
	RMI Corporation			
	Metal Reduction Plant	4.80		
	Sodium Plant	2.70		
	General Tire and Rubber Co.	1.30		

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Athens	Columbus & Southern Ohio Power			
	Poston Plant, Stacks 1 & 2	3.94		Optional compliance equation
	Poston Plant, Stack 3	1.20 (NSPS)		
		7.50		Steam generation
Auglaize	Goodyear Tire and Rubber Co.	4.20		Steam generation
Brown				Not regulated
Butler		1.40	100 grains of H_2S per 100 dscf of COG or 0.5 lbs. SO_2/MBTU input	Steam generation

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Carroll				Not regulated
Champaign				Not regulated
Clark	Ohio Edison Co. Mad River Plant, Stacks 1,2,3 Mad River Plant, Stacks 4 & 5	 4.62 1.00		Optional compliance equation
Clermont	Cincinnati Gas & Electric Co. Beckjord Power Plant	 2.02		Optional compliance equation

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Clinton				Not regulated
Columbiana		4.40		Steam generation
Coshocton	Columbus & Southern Ohio Power Co. Conesville Plant Stacks 1,2,3 Stack 4	 3.78 1.20 (NSPS)		Optional compliance equation
Crawford		9.60		Steam generation

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Darke	X	X	X	Not regulated
Defiance	X	X	X	Not regulated
Delaware		4.00		
Erie		1.60	9.50 lbs. SO_2/ton input	Steam generation

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Fairfield	Diamond Power Specialty Co. Crown-Zellerback Corp. (Number 2 boiler)	6.90 7.00		
Fayette				Not regulated
Fulton				Not regulated
Gallia	Gavin Power Plant Kyger Creek Power Plant	9.50 8.20		

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Comtustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Geauga				Not regulated
Greene			563.3P-0.9027 lbs. SO_2/ton input	General processes
	Wright Patterson Air Force Base			
	Building 271	0.38		
	Building 6770	0.81		
	Building 666	0.33		
	Building 1240	0.79		
	Building 170	0.93		
	Antioch College	6.20 (coal) 1.40 (oil)		
	Central State University	4.30 (Stack 1) .30 (Stack 2)		
Guernsey				Not regulated
Hancock		5.20		Steam generation
	Northern Ohio Sugar Company	2.50		

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Hardin				Not regulated
Harrison				Not regulated
Henry	Napoleon Power Plant	0.00 2.10		Steam generation Steam generation
Highland				Not regulated

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Hocking	X	X	X	Not regulated
Holmes	X	X	X	Not regulated
Huron		8.00		
Jackson	X	X	X	

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Knox				Not regulated
Lawrence		1.22 lbs. SO_2/MBTU or 235 grains H_2S/100 dscf	1.22 lbs. SO_2/MBTU or 235 grains H_2S/100 dscf	Steam generation & process heaters
	Marquette Cement		73.00 lbs. SO_2/ton	
	Dayton Malleable Iron			
	Holding furnace		2.00 lbs. SO_2/ton	
	Cupola		5.40 lbs. SO_2/ton	
	Allied Chemical Co. Semet Solvay Division (Tar pro. boilers 1,2,3)	0.86 lbs. SO_2/MBTU or 165 grains H_2S/100 dscf		
Licking		1.50		Steam generation - oil
Logan				Not regulated

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Madison				Not regulated
Marion		6.10		Steam generation
			4.20 lbs. SO_2/MBTU	General process
Medina		8.00		Steam generation
Meigs			11.0 Lbs. SO_2/ton input	

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Mercer		8.00		Steam generation
Miami		3.20		Steam generation
	Piqua Municipal Power Plant	4.78		Optional compliance equation
			65.0 lbs. SO_2/ton input	General process
Monroe				Not regulated
Morgan	Muskingum River Power Plant	6.48		Optional compliance equation

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Morrow				Not regulated
Muskingum	Philo Power Plant	1.14		Optional compliance equation
			58.0 lbs. SO_2/ton input	General process
Noble				Not regulated
Ottawa		5.90		Steam generation
			47.404 $p^{-0.52}$ lbs. SO_2 per hour	General process

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Paulding			43.0 lbs. SO_2/ton input	
Perry				Not regulated
Pickaway	Pickway Power Plant	4.11		Optional compliance equation
		0.85 (oil)		Steam generation
Pike		7.00		General fuel combustion

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Portage				Not regulated
Preble				Not regulated
Putnam				Not regulated
Richland	Westinghouse Electric Fisher Body Dio-GMC Shelby Municipal Power Plant	4.50 3.10 9.30	7.10 lbs. SO_2/ ton	General process

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Ross	Mead Corporation		4.90 lbs. SO_2/ton solids	
	Stack 1, Boiler 1	0.00		
	Stack 2, Boiler 2	0.00		
	Stack 3, Boiler 3	0.00		
	Stack 4, Chilpalco No. 5	0.00		
Sandusky		7.00		General fuel combustion
	J.E. Baker		48.75 lbs. SO_2/ton	General process
	Woodville Lime Co.		8.48 lbs. SO_2/ton	General process
	Martin Marietta		15.42 lbs. SO_2/ton	General process
	Ohio Lime		17.04 lbs. SO_2/ton	General process
Scioto	Empire Detroit Steel		800 grains/100 dscf or 4.1 lbs. SO_2/MBTU option	COG combustion (H_2S)
		0.60 (oil) 6.90 (coal)		
Seneca		1.20 (oil)		Steam generation
		8.20 (coal)		Steam generation
	Union Carbide		552 lbs. SO_2/ton	Calcining Furnace
			176 lbs. SO_2/ton	Activating Furnace
			34.0 lbs. SO_2/ton	General process

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Shelby				Not regulated
Tuscarawas			37.00 lbs. SO_2/ton	General process
	Dover Municipal Plant	4.60		Steam generation
Union				Not regulated
Van Wert				Not regulated

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Vinton		4.80		Steam generation
Warren				Not regulated
Washington	Muskingum River Power Plant	6.48		Optional compliance regulation
	Shell Oil Co.	2.50		
Wayne	Morton Salt Company	7.00		
	Packaging Corp. of America	7.00		
	Orrville Municipal Power Plant	7.00		

SUMMARY OF PROMULGATED REGULATIONS - RURAL COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Exceptions and Comments
Williams				Not regulated
Wood		1.10	1.10 lbs. SO_2/MBTU	Steam generation and processed fuel
Wyandot				Not regulated

TABLE II - URBAN COUNTIES REGULATION SUMMARY

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Belmont	**Wheeling Pittsburgh Steel Co.** **Martins Ferry Plant**	2.6		

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Cuyahoga		$7.0140 Q_m^{-.3014}$		Steam generation Between 10 and 350 MBTU rated capacity
		1.20		Steam generation Over 350 MBTU rated capacity
			170 grains H_2S/100 dscf	Combustion of coke oven gas
			6.0 lbs. SO_2/ton input	Industrial process
	Allied Chemical Company		4.8 lbs. SO_2/ton 100% acid produced	Sulfuric acid plants
	Republic Steel		240 grains H_2S/100 dscf or 1.22 lbs. SO_2/MBTU	Combustion of coke oven gas at the following facilities: 1. BOF Shop 2. OH Shop 3. Misc. blast furnaces 1, 4 and 5 4. Foundry 5. P Anneals 1-4 6. Car Thaw 1-1 through 1-4
	OH Precipitator, Units 111 & 112	0.00		
	98 inch slab furnace, Units 1 - 5	0.00		
	84 inch slab furnace, Units 1 & 2	0.00		
	Sinter Plant	0.00		
	Boilers 234, 1, 2, A, B, & C	1.00		
	Lake Shore Power Plant (CEI)			
	Unit 18	1.30		
	Units 91 - 94	1.90		
	Cleveland Pumping Station (Boiler)	4.20		
	Hamilton Avenue Steam Plant (Boiler) (CEI)	1.00		
	Addressograph Boilers 1, 2 and 3	1.00		

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Cuyahoga (Con't)	General Electric			
	Boilers 1 and 2	1.00		
	Jones & Laughlin Steel			
	Boiler 30	1.00		
	Boilers 22, 24-29, 31-35	0.50		
	U.S. Steel (Cuyahoga-Lorain Works)			
	Boilers 1 - 6	0.50		
	(Cuyahoga Works)			
	Boilers 3 - 7	1.30		
	Dupont			
	Boiler 18	0.50		
	Harshaw Chemical			
	Boilers 7 and 8	0.50		
	Standard Oil of Ohio			
	Boilers 7, 9, 10	0.50		
	Hupp			
	Boilers 1 through 3	3.50		
	Chase Bay			
	Boilers 1 and 2	4.20		
	General Electric			
	Boilers 3 and 5	3.10		
	General Motors (Fisher body)			
	Boilers 7, 8, 9	2.10		
	Medical Center			
	Boilers 3 - 8	4.60		

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Cuyahoga (Con't)	Ford Motor Company (Stamping Plant) Boilers 1, 2, 3	1.20		
	Ford Motor Company (Engine Plant Number 2) Boilers 1 - 5	4.20		
	Highland View Hospital Boilers 1 and 2	1.50		
	Boilers 3 and 4	2.90		
	Dupont		10 lbs. SO_2/ton 100% acid produced	Sulfuric Acid Plant
	Harshaw Chemical		1.90 SO_2/ton of processed weight	
Franklin		$8.0880 Q_m^{-0.4307}$ (1.5-3.0)		Steam generation Between 10 and 50×10^6 MBTU rated capacity
		1.50		$\geq$ 50 MBTU rated capacity for steam generation
			2.4	General process
			$0.564x^{0.85}$ (Lbs. SO_2/hour)	Zinc smelter
	Columbus State Institution	3.80		Steam generation
	Columbus State Hospital	4.10		Steam generation
	Ross Laboratory	4.80		Steam generation
	Rickenbacher Air Force Base	2.20		Steam generation
	Capital City Products	3.10		Steam generation
	Westinghouse Electric	2.20		Steam generation
	Naval Weapons Industrial Reserve	1.06		Steam generation

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Hamilton		2.00		Steam generation
			0.20 lbs. SO_2/ 1000 lbs. charging stock	Catalytic crackers
			21.0 lbs. SO_2/ ton of 100% acid	Sulfuric acid plant
	Miami Fort Power Plant			
	Stack 2	0.30		
	Stacks 3 & 4	3.30		
	Stack 5	5.50		
	Stack 6	1.20 (NSPS)		
Jefferson		1.80		Steam generation - coal
		0.80		Steam generation - oil
			50 grains H_2S/ 100 dscf	Coke oven gas limitation
	Kaul Clay Co.	2.82		
	Toronto Paper Board Co.	5.96		
	Toronto Power Plant	8.10		
	Sammis Power Plant	2.91		Optional compliance equation
	Cardinal Power Plant	4.76		Optional compliance equation
	Tidd Power Plant	1.58		Optional compliance equation
	Yorkville Steel Plant (Wheeling Pittsburgh Steel)	4.20		

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Lake		$14.976Q_m^{-0.3431}$		Between 10 and 1000 MBTU rated capacity
		1.40		$\geq$ 1000 MBTU rated capacity
	Ohio Rubber Co.	6.00		
	Painesville Mun. Power Plant			Steam generation
	Boilers 1 - 4	5.20		
	Boiler 5	1.20 (NSPS)		
	Diamond Shamrock	0.00		Steam generation
	East Lake Power Plant	1.43		Steam generation Optional compliance equation
	Lubrizol Corp.		20.0 lbs. SO_2/ ton input	
Lorain		$21.176Q_m^{-0.5477}$		Steam generation Between 10 and 100 MBTU rated capacity
		1.70		$\geq$ 100 MBTU rated capacity
	Avon Lake Power Plant	1.15		Steam generation Optional compliance equation
	Edgewater Power Plant	3.40		Steam generation
	United States Steel Corp.			
	Processess P033 & P039		35 grains H_2S/ 100 dscf or 0.10 lbs. SO_2/MBTU	COG limitation
	All other processess		75 grains H_2S/ 100 dscf or 0.40 lbs. SO_2/MBTU	COG limitation
	Boilers 1 - 9			Steam generation
	Boilers 10 - 13			Steam generation

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Lorain (Con't)	General Motors			
	Boilers 1 & 2	0.80		Steam generation - oil
	Boiler 4	0.90		Steam generation - oil
Lucas		1.50		Steam generation - coal
		1.00		Steam generation - oil
	Bayshore Station	1.30 (coal) 0.40 (oil)		
	Acme Power Plant	2.00 (coal) 0.80 (oil)		
	Standard Oil of Ohio Boilers & process heaters	0.50	0.50	
	P001		46 grains H_2S/ 100 dscf	Refinery off-gas combustion
	P002		0.3 lbs. SO_2/1000 lbs. input	Catalytic cracking units
	P003		0.11 lbs. SO_2/ ton input	General process

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Lucas (Con't)	Coulton Chemical Company	0.30		Steam generation
			6.5 lbs. SO_2/ton acid produced	Sulfuric Acid Plant
	Gulf Oil	0.30		
	P003		0.30 lbs. SO_2/1000 lbs. charging stock	Catalytic cracking units
	P005		64.4 lbs. SO_2/ 1000 lbs. sulfur	Sulfur recovery
	Toledo Edison Co. Water Street Steam Plant	0.80		
	Phillips Petroleum Co. Toledo Philblack Plant	0.80		Steam generation
			5.45 lbs. SO_2/ton input	General process
	Interlake Steel	0.80		Steam generation
			4.93 lbs. SO_2/ton input	General process
	Nabisco	1.20		
	Sun Oil	0.50	0.50	Steam generation & process heaters
			2.0 lbs. SO_2/ton input	General process
	Toledo Hospital	3.50		
	Seneca Petroleum	1.20		

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Mahoning		0.50		Steam generation
			1.00 lbs. SO_2/ ton input	General process
			100 grains H_2S/ 100 dscf or 0.50 lbs. SO_2/MBTU	COG combustion limitation
	Ohio Edison Co. North Avenue Steam Plant	2.00		Steam generation
	Lonardo & Sons Greenhouse	2.00		
	Whiteacre-Greer Fireproofing		20 lbs. SO_2/ ton input	
Montgomery		1.60		Steam generation
	Dayton Power and Light Co.			
	Longworth Street Station	0.65		Steam generation - oil
	Third Street Station	0.65		Steam generation - oil
	Yankee Substation	0.65		Steam generation - oil
	Monument Substation	0.65		Steam generation - oil
	Tait Power Plant	1.25		Steam generation - coal
		0.65		Steam generation - oil
	Hutchings Power Plant	1.20		Steam generation - coal
		0.65		Steam generation - oil
	Delco Corp.	1.30		Steam generation
	Defense Electronics Supply	0.95		Steam generation
			2.6 lbs. SO_2/ ton input	General process

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Stark		$18.480Q_m^{-0.4886}$ (2.5-6.0)		Between 10 and 60 MBTU rated capacity Steam generation
		2.50		$\geq$ 60 MBTU rated capacity
			350 grains H_2S/100 dscf or 1.70 lbs. SO_2/MBTU	COG combustion limitation
			80 lbs. SO_2/ton input	Industrial process
	Republic Steel Corp. Massilion facilities	4.40		Steam generation
	Massilion State Hospital	5.20		
	Grief Board Company	0.50		
	Timken Steel Company	1.20 0.60		Steam generation - coal Steam generation - oil
	Ashland Oil Company			
	4-16-B-11 and 4-0-B-6	1.20		
	Remaining stacks	0.85		
	Catalytic Cracker		97.5% SO_2 removal efficiency	

SUMMARY OF PROMULGATED REGULATIONS - URBAN COUNTIES

County	Named Facility	Fuel Combustion (Lbs. SO_2/MBTU Heat Input)	Industrial Processes	Comments
Summit		$17.55Q_m^{-0.3993}$ (1.8-7.0)		Between 10 and 300 MBTU rated capacity
		1.80		$\geq$ 300 MBTU rated capacity
	Diamond Crystal	6.10		Steam generation
	Akwell Industries	3.60		Steam generation
	Ohio Brass Co.	4.20		Steam generation
	Sieberling Tire & Rubber Co.	1.00		Steam generation
	Firestone Tire & Rubber Co.	1.50		Steam generation
	Goodrich Tire & Rubber Co.	1.90		Steam generation
	Goodyear Tire & Rubber Co.	1.00		Steam generation
			100 lbs. SO_2/1000 lbs. sulfur processed	Sulfur recovery
	Tecumseh Co.	1.70		Steam generation - coal
		0.70		Steam generation - oil
	Ohio Edison Co.			
	Beech Street Power Station	4.10		
	Gorge Power Plant	2.10	17.0 lbs. SO_2/ ton input	General process
Trumbull		3.00		Steam generation - coal
		1.00		Steam generation - oil
	Republic Steel Co.			
	Unit B001	0.20		Steam generation
	Process operation P001	1.00		
			300 grains H_2S/ 100 dscf	COG combustion
			2.00 lbs. SO_2/ MBTU input	General process
	Ohio Edison Co.			
	Niles Power Plant	5.41		Optional compliance equation
	U.S. Steel Corporation McDonald Mills	0.50		

SECTION I

ASSESSMENT OF PUBLIC COMMENTS

Section I. ASSESSMENT OF PUBLIC COMMENTS

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SECTION I. ASSESSMENT OF PUBLIC COMMENTS

INTRODUCTION

This Section of the Technical Support Document describes how EPA involved the public in this rulemaking action, and sets forth the Agency's response to substantive issues raised by the interested public.

A. General Approach

In order to insure the validity of the promulgated sulfur dioxide regulations, and to conform to the requirements of the Administrative Procedures Act, EPA solicited public participation in the rulemaking process. The preamble to the proposed regulations (40 FR 52410, November 10, 1975) set forth the opportunities for and conditions upon public review and comment of the proposal. Documentation supporting the technical basis for the Administrator's action was made available for review at twenty locations throughout the State of Ohio as well as at the EPA Region V Office in Chicago and the EPA headquarters in Washington, D.C. Copies of the Technical Support Document were made available upon request to persons contacting the EPA Region V Office. Written public comments were solicited through January 23, 1976. Public hearings were held in Cincinnati, Cleveland, Steubenville and Columbus, Ohio on December 18, 1975, and January 6, 8, 13 and 14, 1976, respectively. A large number of individuals and organizations provided their commentary to EPA.

A list of persons who participated in the rulemaking by submitting written documentation appears in the appendices to the Technical Support Document to the final rulemaking. The complete public record is available for review at the Region V EPA office. A large volume of material was received including general citizen support, highly detailed independent technical analyses, emissions data, air quality data, technological and economic feasibility commentary, and comments on administrative, procedural and legal aspects of the action. In view of the large volume of material received, the repetitiveness of some comments and the subtle variations on general themes, EPA determined that it was not necessary or desirable to address each individual comment in this support documentation. Nevertneless, each document submitted (and the record of the public hearings) was reviewed and considered in order to identify:

1. Data potentially useful as input in the dispersion modelling methodologies applied in the county-by-county reevaluation of the proposed control strategy;

2. Suggestions pertaining to the structure of the regulations and the technical adequacy of the methodologies (and their inherent assumptions) utilized in developing the regulations;

3. Comments pertaining to numerous but inportant peripheral issues related to compliance schedules, technological and economic feasibility, stack height increases, health effects,

atmospheric sulfates, air quality maintenance requirements, and others.

In Section I(B) EPA has identified the major issues raised by the public and has provided the Agency's response. In some instances reference is made to other Sections of the Technical Support Document to the final regulations. The Agency's response to the issues raised by the public is reflected in the methodologies, data base and assumptions used in developing the promulgated regulations. The entire Technical Support Document must therefore be considered in evaluating EPA's response to public comments.

B. Discussion of Issues

1. Miscellaneous Comments

Comment:

A number of commenters pointed out that the regulations would permit increases in SO_2 emissions in certain areas of Ohio or for particular point sources, contrary to EPA policy on atmospheric sulfates. Related comments noted that the EPA technical analysis took no account of TSP/SO_2 interaction, atmospheric sulfates or sulfuric acid mist.

Response:

EPA's promulgated regulations meet the requirements of Section 110 of the Clean Air Act in providing for attainment and maintenance of the NAAQS for SO_2. This rulemaking is also consistent with EPA's sulfates policy (Position Paper on

Regulation of Atmospheric Sulfates; September 1975). The overall impact of these regulations will be to reduce SO_2 emissions. Although some limited increases will be permitted at a few sources the sulfate loading in the atmosphere generally will be decreased substantially. Also, those sources which are currently operating at emission rates which are in compliance with these regulations are probably doing so for one of two reasons. The firest reason would be the existence of local regulations requiring the source to maintain a particular emission rate. The EPA promulgation in no way invalidates such requirements and, in fact, EPA supports State and local governments who choose to exercise their prerogative under §116 of the Clean Air Act to develop and enforce regulations which go beyond the minimum requirements to achieve the NAAQS.

The second reason that certain sources are operating at emission levels below those allowed by the promulgated regulations is due to economics. It generally is necessary for sources to incur costs in order to adjust boilers to handle higher sulfur coals and to change their coal supply. Therefore, it is not likely that sources already in compliance with the promulgated regulations would move to significantly increase their SO_2 emissions. In any event EPA's final requirements ensure attainment and maintenance of the NAAQS through 1985.

Comment:

Some commenters suggested that EPA allow stack height increases and supplementary control systems (SCS) as general means of meeting the NAAQS. The arguments made in favor of such a strategy are generally economic in nature.

Response:

The EPA policy regarding use of dispersion dependent technology as the primary means of achieving the ambient air quality standard is set forth in detail in the "Stack Height Increase Guideline" (41 FR 7450), published February 18, 1976. The policy, which is based directly on several court decisions, holds that dispersion dependent technology can be used on a limited basis only after constant emission limitations have been employed to the maximum extent achievable. Detailed source specific technical studies are required to determine if a facility meets the tests before stack height increases may be allowed. EPA has reviewed the comments and statements submitted in response to this rulemaking and concluded, based on this record, that no source currently qualifies for an exception to these final emission limitations based on stack height increase. In addition, EPA conducted a number of site studies and these studies demonstrate that with careful planning and consideration the various alternative compliance programs can overcome most site specific physical constraints. However, if an owner or operator has sufficient information after promulgation of these requirements to demonstrate conclusively the infeasibility of EPA's regulations, the Administrator will consider a petition for revision of the emission limitation as it applies to that facility.

Comment:

EPA's administrative provisions for public participation in the rulemaking process were critized as follows:

1. The TSD did not contain sufficient information to allow the public to determine the data based used;

2. The TSD was complex, full of errors, and difficult to penetrate;

3. Inadequate time was allowed for public comment;

4. Cross-examination of EPA witnesses should have been allowed;

5. At the hearings a disproportionately small amount of time was devoted to environmentalists compared to industry.

Response:

While the quality of reproduction of certain data base portions of Volume II of the TSD was poor, EPA responded promptly to all requests for detailed data base information. EPA has revised the format for the TSD to the promulgated regulations in an effort to enhance its clarity and ensure that the public is fully advised of the basis for EPA's action.

The Sixth Circuit, in Buckeye Power, et. al. vs. EPA, 481 F. 2d 162 (1973), advised that the Administrator's actions under § 110 of the Clean Air Act were not subject to adjudicatory-type rulemaking requirements. Accordingly, the right to cross-examine witnesses was not observed at the public hearings. The Court also noted that § 553 of the Administrative Procedures Act requires rulemaking agencies to involve the public in their actions in order to insure that all relevant factors were brought to the Agency's attention. Therefore, EPA set up a series of public meetings at widespread locations in the State of Ohio (Cleveland, Columbus, Steubenville, and Cincinnati) in order to allow a high degree of public participation. The hearings were well attended with several sessions extending into the evening hours. Due to extensive public interest in Columbus, the hearing, which began on January 13, 1976, was reconvened on the 14th.

Also, a tremendous volume of written comment was received, such as general comments from individual citizens, detailed commentary and independent analyses from citizen groups and industries, and large quantities of air quality and emissions data. The sheer volume, together with the degree of sophistication of some of the public comments, is indicative of the Agency's success in involving the public in this rulemaking process.

Comment:

It was stated that EPA should have reviewed and considered the record of the previously held lengthy state adjudicatory hearings.

Response:

This criticism was inappropriate since all the commenter needed to do to insure EPA review of the subject matter would be to submit appropriate portions as part of the public comment record. In addition, EPA has a responsibility under the law to base its rulemaking on procedures required by Federal statutes.

Comment:

One commenter alleged that the EPA proposal was procedurally deficient in that an Inflation Impact Statement (IIS) was not prepared pursuant to Executive Order 11821 (39 FR 41501, November 29, 1974), prior to proposal and made publicly available.

Response:

Prior to proposal of the EPA SO_2 plan for Ohio, EPA had not yet finalized its guidelines designating those regulatory actions which would be subject to the President's order. There were strong indications that regulatory actions affecting only one State would not be subject to IIS requirements. Accordingly, no IIS was prepared at the time of proposal. Moreover, it is EPA's view that the Inflation Impact Statement is not reviewable by private persons as provided in a recent 8th Circuit Court of Appeals ruling which concluded that the President did not undertake or intend to create any role for the judiciary in the implementation of E.O. No. 11821. The appeals court held further that the district court erroneously set aside the revised regulations in their entirety because of alleged deficiencies in the impact statement. However, EPA is considering inflationary impacts in connection with the final rulemaking action and the IIS will be available to the general public shortly after promulgation.

Several persons commented that the EPA proposal is deficient in that it did not specifically provide for various resource elements required under Section 110(a)(2) of the Clean Air Act, such as personnel, funding, reports, ambient monitoring and new source review procedures.

Response:

Section 110(c) requires the Administrator to "promptly prepare and publish proposed regulations setting forth an implementation plan . . ." and later on to ". . . promulgate any such regulations." Thus, when EPA engages in substitute rulemaking because of state plan deficiencies, its correcting action is limited to regulatory actions. Except for new source review procedures, all of the above-mentioned elements are non-regulatory and therefore not subject to the §110(c) mandate. The State's procedures for new source review were approved on April 15, 1974, and remain effective for purposes of determining compliance with SO_2 requirements.

Comment:

One commenter claimed that EPA does not have the authority to promulgate mandatory fuel standards as contained in proposed regulation § 52.1881(b)(12).

Response:

Sulfur-in-fuel content regulations are effectively emissions limitations and are clearly authorized by the §110 authority to promulgate "emission limitations . . . and such other measures as may be necessary to assure attainment and maintanance . . . of the NAAQS."

Comment:

Two commenters recommended that EPA utilize an emission tax or incentive approach to achieve the NAAQS.

Response:

This approach to SO_2 emissions control has been the subject of some discussion. Outside of EPA's lack of authority in the Clean Air Act for such an approach, two principal problems with the approach create serious doubts as to workability:

1. setting of an appropriate tax rate; and
2. the tax will probably be passed on to the consumer without resulting in a reduction in emissions.

The National Academy of Sciences has recommended that the approach be the subject of further study.

Comment:

Mead Corporation commented that EPA should have recognized the Consent and Abatement Order issued by the State of Ohio for the Chillicothe Mills in late 1974. Mead claims that the subject order, which limits the emissions of SO_2 from four coal fired boilers, comprises a comprehensive SO_2 control strategy sufficient to protect the SO_2 NAAQS.

Response:

EPA has considered this consent order and determined it is not adequate to assure attainment of the NAAQS for two reasons. First, this consent order is not enforceable by the USEPA. Also, the consent order covers only a portion of the facility and as such does not ensure the attainment of the NAAQS. EPA promulgated requirements with respect to Mead Corporation impose no requirement on facilities connected to the major stack, and ensure shutdown of facilities connected to the shorter stacks as stated by Mead Corporation in correspondence of May 12, 1976.

Comment:

Some commenters stated that companies would have to scrap plans for compliance with particulate matter emission limitations if SO_2 regulations are promulgated. One commenter urged EPA to proceed quickly with promulgation of the SO_2 regulations so that compliance with particulate matter regulations can proceed effectively.

Response:

On numerous occasions, EPA has recognized the vailidity of arguments concerning the interdependence of SO_2 and particulate matter control in certain circumstances. The Agency's response to this argument has consistently been to handle claims of interdependence on a case-by-case basis through enforcement mechanisms. Extension of the Ohio attainment date for particulate standards as proposed by EPA on January 14, 1976 (40

FR 2099), should alleviate some problem situations. Finalization of this extension is expected shortly.

Comment:

One commenter stated that EPA was required to prepare an Environmental Impact Statement (EIS) to meet the requirements of the National Environmental Policy Act.

Response:

Section 7(c)(1) of the Energy Supply and Environmental Coordination Act (P.L. 93-319) provides as follows: "No action taken under the Clean Air Act shall be deemed a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969." Therefore, no EIS was prepared for this federal action.

Comment:

One commenter stated that isolated, infrequent violations (on the order of three or four days per year) of the NAAQS should be allowed, as considerable economic savings would result.

Response:

The 24-hour standard for sulfur dioxide is 365 ug/m^3 not to be exceeded more than once per year. Once a standard has been set, EPA cannot promulgate regulations to achieve something less whithout violating Clean Air Act requirements to develop a plan to attain and maintain the NAAQS.

Comment:

One commenter queried why the regulations did not include procedures to grant relief to insignificant sources consistent with the Supreme Court decision.

Response:

EPA's final promulgated requirements are the minimum necessary to assure attainment and maintenance of the NAAQS. Insignificant sources are not covered by this rulemaking; therefore, a procedure for exemption of such sources is not necessary. Moreover, EPA intends to handle any necessary extensions to compliance in the enforcement process.

Comment:

A few commenters questioned the validity of the NAAQS for SO_2. The standards were criticized as being too high by some commenters, and as being too low by others.

Response:

In 1974, the National Academy of Science issued a report addressing the validity of the NAAQS. The Academy concluded that there was no scientific evidence available to justify revising the NAAQS at this time.

Moreover, criticism relating to the validity of current air quality standards for SO_2 are inappropriate to this rulemaking action. The standard has been set; the period for challenging its validity is long past. Section 110 requires a plan to achieve the standard and this requirement is the only subject of this rulemaking.

2. Technological Feasibility

Comment:

Statements concerning the status of flue gas desulfurization (FGD) for use in fossil fuel-fired steam generating units ranged from very positive to very negative. On the positive side we received statements to the effect that the technology is well demonstrated and reliable when given competent attention, that the costs of FGD are viable when compared to other compliance alternatives, and that the pollution control industry has the capacity to meet national FGD needs projected through the early 1980s. On the negative side, some commenters maintained that long-term demonstration of reliable operation of FGD on a typical coal fired baseload power plant has not yet been accomplished; that the FGD reduces utility system reliability and imposes an unacceptable energy penalty on the system; that technology has not been demonstrated to be feasible for application to industrial boilers or small utilities, or for use with high sulfur coal; that the problem of disposal of scrubber sludge has not been solved in an acceptable manner; or that site specific considerations preclude FGD installation at a particular facility.

We also received both positive and negative comments regarding the technological feasibility of the regulations applying to coke ovens, sulfuric acid manufacturing plants, sulfur recovery plants, process equipment and petroleum refineries. On the positive side, Peabody Galion Corporation, a manufacturer of fuel and flue gas desulfurization systems said that the regulations as proposed for coke oven gas, sulfur acid plants and sulfur recovery plants are achievable by current proven technology. Also, Allegheny County, Pennsylvania and the West Virginia Bureau of Air Pollution Control are currently enforcing a regulation similar to or more stringent than the one promulgated for coke ovens in Ohio. On the negative side, several industries alluded to particular physical constraints at their facilities or the high costs which would have to be incurred in order to achieve compliance.

Response:

In the Technical Support Document to the proposed rulemaking, EPA addressed the technological feasibility of the proposed regulations, and demonstrated that the proposed emissions limits had been achieved with existing technology at retrofitted sources. EPA believes that the evidence is conclusive, and that the proposed regulations are generally feasible at a great number of sources through retrofitted controls or fuel switching.

The promulgated regulations are in some instances somewhat different from the proposed regulations in terms of their stringency. The final regulations tend to be slightly less restrictive than the proposed requirements. These changes result from the modelling reevaluation which incorporated consideration of data provided during the public comment period. Also, the regulations for petroleum refineries were changed in form, in response to public comments, to more substantially reflect actual operations at refineries. Nevertheless, EPA has addressed in detail the technological feasibility of the promulgated regulations in Section V.

In addition, EPA contractors conducted inspections under the authority of Section 114 of the Clean Air Act of facilities exemplifying various site specific considerations which might impede the implementation of a compliance program. The contractors then prepared a report outlining potential alternative emission control programs and describing in detail the most probable approach, in the contractor's judgement, to compliance with the proposed regulations. The following facilities were inspected and the final reports are available for inspection at the Region V EPA office:

1. PPG Industries (Barberton) - Large Coal Fired Boiler
2. Union Camp Corporation (Dover) - Average Size Boilers
3. Youngstown Sheet and Tube Co. (Struthers) - By Product Coke Ovens
4. Mead Corporation (Chillicothe) - Large Boilers
5. Republic Steel Corp. (Cleveland) - Integrated Iron and Steel Plants
6. The Standard Oil Co. of Ohio (Lima) - Refinery with Sulfur Recovery Plant
7. Union Carbide Corp. (Fostoria) - Activated Carbon Mfg.
8. Phillips Petroleum (Toledo) - Carbon Black Mfg.
9. E. I. Dupont (Cleveland) - Sulfuric Acid Plant
10. Cleveland Municipal Power Plant

11. Gavin Power Plant
12. Muskingum River Power Plant
13. Kyger Creek Power Plant
14. Acme Power Plant
15. R. E. Burger Power Plant
16. W. H. Sammis Power Plant
17. Norwalk Power Plant
18. W. C. Beckjord Power Plant
19. Poston Power Plant
20. Conesville Power Plant

The studies demonstrate that careful planning and the consideration of alternative compliance programs can overcome most site specific physical constraints.

3. Regulations

Comment:

We received considerable public comment on the omission in the proposed plans of specific regulations applicable to new sources.

Response:

Regulations applicable to all significant new sources have already been promulgated on a State and national basis. A State permit to allow the construction of new sources or the modification of existing sources cannot be issued to new sources, subject to certain exemptions, until the Ohio EPA determines that operation of the new source (or modified source) would not interfere with the attainment or maintenance of the Ohio air quality standards. In addition, new facilities subject to the New Source Performance Standards (NSPS) must comply with the NSPS standards at a minimum regardless of their proposed geographic location. Also, certain categories of new (or modified) sources are subject to the Federal Regulations (40 CFR 52.21) for the Prevention of Significant Air Quality Deterioration (PSD). Sources covered by the PSD regulations are currently required to obtain a permit to construct from the Region V office of the EPA. It is noted that a source subject to more than one of the above regulatory requirements must comply with whichever requirement is more stringent. EPA has therefore concluded that the existing mechanism for the review of new or modified sources is adequate to protect both the NAAQS and the significant deterioration increments.

Comment:

One commenter suggested that the implementation plan provide for attainment of the ambient air quality standards previously adopted by the State of Ohio, which are more stringent than the Federal NAAQS.

Response:

This cannot be done since EPA's authority under Section 110 of the Clean Air Act is limited to the promulgation of a plan to attain and maintain the national standards.

Comment:

In the preamble to the proposed regulations, the Administrator solicited comments on the need for the appropriate content of provisions in the regulations to deal with violations of the emission limitations should control equipment become unavoidably inoperative. Specifically, the Administrator requested information from sources covered by the proposal regarding the kind of control equipment they plan to install, why such equipment may malfunction, circumstances that would necessitate continued source operation during the period of malfunction, alternative methods of controlling emissions to comply with regulations during such periods, and methods of documenting control equipment downtime. Little response was received to this solicitation. A few commenters recommended that specific malfunction requirements should be included in the regulations in order to insure fairness and consistency, but no detailed suggestions were provided.

Response:

The Administrator has found no basis in the record to revise his determination that violations of the emission limitations that occur during periods of equipment malfunction can be resolved through enforcement discretion. It should be noted that Ohio EPA regulations require that certain reporting and correctional steps be taken by source operators during periods of malfunction or scheduled maintenance.

Comment:

One commenter noted that the proposed plan contained no regulations directed to the control of emissions from State or Federal facilities.

Response:

This is not the case. No specific regulations were necessary, since State and Federal facilities must comply with the applicable emission limitation contained in the SIP for their geographic area and facility type. However, in certain instances specific State and/or Federal facilities are named within the final regulation where a specific emission limitation is needed for such a facility.

Comment:

Considerable comment, both pro and con, was generated on the county-by-county approach utilized in developing the proposed regulations. Some commentors expressed the opinion that regulations should be in effect only where violations of the NAAQS are well-documented through ambient monitoring and should apply only to those sources found to be primarily responsible for the violations. A number of comments reflected a desire for uniformity in requirements throughout the State or throughout regions within the State, pointing out that similar facilities which may be competitors could be subject to vastly different requirements depending upon their geographic locations. At least one comment suggested regulations on an AQCR basis.

Response:

EPA has pointed out, on a number of occasions, that the purpose of this rulemaking is to provide for attainment and maintenance of the SO_2 NAAQS as required by Section 110 of the Clean Air Act. The authority to implement more stringent requirements is reserved solely to the States, by Section 116 of the Act. EPA's modelling results clearly show that the relationship between SO_2 emission rates and resulting ambient air quality varies greatly across the State. Therefore, the concept of Statewide, or "AQCR wide," regulations is ruled out in Ohio due to the impossibility of satisfying the Clean Air Act requirement to set emission limitations that attain and maintain the NAAQS and preserve the rights of the States under Section 116. EPA recognizes a number of advantages in the sub-county and source specific approaches to regulating emission sources. EPA determined that the best approach in the final rulemaking was to develop flat rate or sliding scale regulations on a county basis while regulating certain sources on an individual basis. The individual analysis of each county dictated the final format for the county. Among the criteria used for being facility specific in the final strategy were: 1) a county wide regulation would allow specific sources to increase emissions to the extent that the standards would be threatened; 2) a county wide regulation would impose unjustifiable controls on isolated sources; and 3) a county wide control would impose control requirements which are clearly technologically infeasible or economically unreasonable. EPA feels that the advantages of this approach are obvious: 1) unnecessarily stringent regulations and resultant economic burdens are reduced; 2) implementable regulations result; and 3) most importantly, attainment and maintenance of the standards is assured.

Comment:

A few commenters objected to the lack of regulations in the proposal for existing sources in thirty-two counties.

Response:

EPA adequately explained this situation in the Technical Support Document to the proposed rulemaking. To summarize that discussion, EPA determined that existing sources in those counties, with operations projected to maximum capacity, pose no threat to the SO_2 standards and the Prevention of Significant Deterioration (PSD) increments in the future. In the promulgated regulations, 33 counties are unregulated for the reasons presented in the TSD to the proposed rulemaking.

Comment:

EPA received a number of comments objecting to the application of the regulations to individual emission points as opposed to facility-wide regulations. A facility-wide regulation, it was stated, would enable the manager of a facility to decide the most economic and practical way to reduce emissions from the facility. Other commenters suggested, however, having unit-by-unit regulations based on capacity, fuel use, and stack height, and separate requirements for each manufacturing process within a facility.

Response:

As in the proposal, the final regulations generally require controlling emissions to specific limits at individual emission points (i.e., stack-by-stack). EPA feels that a stack-by-stack approach is necessary to assure achievement of the standards without placing overly restrictive requirements on individual facilities. This conclusion is based on the fact that different stacks, for a given emission rate, have different impacts on ambient air quality. The stack-by-stack approach leads to regulations which assure standards achievement, yet allows facility managers flexibility to decide the most economical and practical way to control all units connected to a common stack. As an improvement on this approach, in consideration of the public comments, EPA has found it feasible in the case of certain isolated facilities to allow even greater flexibility to managers in the selection of control programs while still assuring standards achievement. This is accomplished in the regulations by setting forth the relationship between the emission rate (under worst case conditions) at each individual stack and the ambient air quality impact of those emissions at the location of critical receptors. The facility manager may choose any combination of emission limitations on a stack-by-stack basis such that the aggregate impact of the facility does not exceed the NAAQS or the Class II PSD increments at each critical receptor. The emissions-air quality relationship set forth in the regulations is that established by an improved version of the MAX-24 model which was used in developing both the proposed and the promulgated regulations. This regulatory approach requires no additional assumptions by EPA relative to the MAX-24 methodology utilized in developing the proposed regulations, yet allows the opportunity for substantial cost savings while assuring achievement of the standards.

Comment:

The use of a sliding scale based on source size to determine applicable emission limitations elicited a number of comments. Many commentors supported the use of a sliding scale, and some suggested incorporating additional factors, such as age of the facility, into the scale. Some commenters objected to the use of sliding scales as counterproductive, on the grounds that the large facilities often have taller stacks than the small ones, and therefore have less impact on the ambient air quality in proximity to their facilities, yet they receive the most restrictive emission limitations.

Response:

The methodologies utilized by EPA in developing the final promulgated regulations substantially addresses this issue.

As explained in detail in Section IV and VIII of the Technical Support Document, the allowable emissions for each source were approximated by requiring emission reductions in proportion to the relative contributions of the sources at the critical receptors (for the RAM and CDM methodologies). A curve fitting procedure was then utilized to develop the promulgated sliding scales as a function of rated capacity. Sources which did not adequately fit the curve receive individual emission limits in the promulgation.

Comment:

Several commenters proposed changes to the regulations for specific counties.

Response:

In all cases, such comments did not include adequate data to warrant such changes and did not include an adequate demonstration that the control strategy they proposed would suffice to attain and maintain the standards. Clearly, EPA cannot promulgate regulations which are not supported by adequate data and a control strategy demonstration which assures that the NAAQS will be achieved. The Clean Air Act requires that a control strategy assure attainment and maintenance of the NAAQS.

Comment:

A substitute definition of "process weight" applicable to fluid catalytic cracking was proposed as follows: "Process weight means the material introduced as a fresh feed and unconverted material introduced as recycle."

Response:

EPA has expanded the definitions in the final regulations to include a definition of "fresh feed stock" for catalytic cracking units. This definition is necessary in order to make the determination of allowable SO_2 emissions from petroleum refinery catalytic cracking units. The dispersion modelling for such units was carried out using the emission factors from EPA publication AP-42. The appropriate emission factors are defined in terms of "fresh feed" and to use another definition in the regulations would be inappropriate.

Comment:

It has been suggested that the definition of sulfur recovery plants be modified to include all sulfur recovery plants even when installed for the purpose of preventing emissions of sulfur dioxide or other sulfur compounds. Otherwise, an inefficient recovery plant could negate the effect of applying Section 1881(b)(9) to a refinery. Also, Standard Oil requested clarification of this definition, since the applicability of the regulation to refineries is questionable.

Response:

The exceptions for sulfur recovery and sulfuric acid plants used for preventing emission of sulfur oxides have been removed since they are no longer necessary, given the source-specific emission limitations for sulfur recovery plants and sulfuric acid plants in the final regulations.

Comment:

A few comments stated that the regulations applicable to petroleum refineries (52.1881(b)(9)), is discriminatory since it is more restrictive than the regulations for combusion of fuels. The regulation applicable to by-product coke oven operations (52.1881(b)(12)) elicited a number of comments to the effect that the regulation is more stringent than necessary to meet and attain the NAAQS. It is discriminatory because it is more stringent that the regulations for the combustion of other fuels, and it may eliminate the supply of coke oven gas as fuel. Standard Oil wants all fuel combustion units regulated on the basis of heat input (using sliding scale). This will allow refineries flexibility to use fuels as they become available.

Response:

EPA's final regulations are not discriminatory since the requirements are not preselected but directly based on a source's contribution to an area's air quality problem. All overly stringent requirements have been eliminated in this final rulemaking. Flexibility has been provided in the final regulations, where feasible, and where achievement of the NAAQS would not be jeopardized.

Comment:

It has been suggested to exempt emergency flares from the regulations, since the provision of treatment facilities for such flares is neither technically nor economically feasible.

Response:

This exemption has been included in this final rulemaking since it is not believed this would adversely affect achievement of the NAAQS.

Comment:

One commenter suggested that specific regulations be set for carbon black plants which, in the proposal, were covered by the general process regulation.

Response:

Specific emission limitations for a facility are only given when the facility is isolated or the requirement can be more or less stringent than the general requirement and still assure achievement of the NAAQS.

Comment:

Several commenters stated that the distinction in the proposed regulations between facilities using fuel combustion for steam generating purposes, and facilities using fuel combustion for heat exchange in industrial process is not warranted.

Response:

In the final rulemaking the EPA has reevaluated its process regulation which covered heat exchangers which were not steam generators. Where warranted, the applicable regulation is one of fuel quality similar to the regulation for steam generators.

4. Compliance Schedules

Comment:

The compliance schedules proposed in the plan generated several comments. Some expressed concern that a number of facilities might be allowed more time for compliance than they actually need, while others maintained that the schedules are too short to be met by most facilities. The three year compliance schedule for installation of FGD systems elicited substantial public comment. Some utilities submitted statements that the schedule could not be met at specific plants. The Industrial Gas Cleaning Institute, which is an organization representing vendors of pollution control equipment, pointed out that the three-year schedule would be especially hard to meet for utilities with several plants with multiple units requiring FGD. FEA expressed interest in phase-in scheduling of various FGD systems, to coordinate the times that generating capacity will be removed from service to install the necessary equipment.

Response:

Under Section 110 of the Clean Air Act, the implementation plan must provide for attainment of the primary standard within three years of promulgation of the plan, and attainment of secondary standard within a reasonable time thereafter. With insignificant exception, the primary standard has proven to be the more restrictive standard in Ohio. Therefore, none of the promulgated compliance schedules extends beyond three years. EPA believes that the promulgated compliance schedules, although rigorous, are feasible and they can be met by most facilities which proceed with compliance plans without delay. Nevertheless, EPA recognizes as a practical matter that some sources will prove to be exceptions in that: 1) expeditious action on the part of the source owners may enable compliance over a shorter time frame than that provided by the promulgated compliance schedules; or 2) compliance within the time frame set by the promulgated schedules may prove physically impossible. EPA continues to believe that such exceptional cases are best identified through the enforcement process due to the detailed source specific factors which must be evaluated. The EPA regulations pertaining to compliance schedules afford the flexibility to adjust compliance schedules on a case-by-case basis if necessary.

Moreover it is now four years since the State of Ohio should have had a sulfur dioxide plan in effect. Timely expeditious action by the affected sources is certainly called for even if extraordinary means are needed to meet expedited schedules.

Comment:

A few commenters pointed out an inconsistency in the compliance schedule for fossil fuel-fired steam generating units. Under the proposed schedule (52.1882(a)(4)(i)), within four weeks after promulgation the owner or operator of a fossil fuel-fired steam generating unit must notify EPA of his intent to utilize either low sulfur fuel or FGD to comply with the requirements of the applicable regulations. Within three weeks of the date of promulgation, however, the owner or operator must submit (52.1882(a)(4)(ii)(A)) a projection for ten years of the amount and types of fuel that will be substantially adequate to enable compliance with the regulations.

Response:

The "three week" figure reflects an error due to partial obscuring of the numeral "8" during reproduction. The promulgated compliance schedule has been corrected to read eight weeks as originally intended.

Comment:

We received a great deal of comment on the requirement that sources electing to comply by using low sulfur fuel enter contracts for a ten-year supply of fuel (52.1882(a)(4)(ii)) with the appropriate characteristics to enable compliance with the regulations. Many of those commenting found such a requirement to be unnecessary, unrealistic, and burdensome to owners and operators of industrial boilers and small coal consumers. Others maintained that flexibility in selecting fuel suppliers is essential in attaining good quality coal.

Response:

This contract requirement has been deleted. Nevertheless, the regulation requires sources to submit information regarding short-term commitments to fuel supplies. EPA believes that, considering the structure of the coal industry, this improves the probability that sources will be able to obtain supplies of complying coal in the long run.

5. Growth Projections and Maintenance

Comment:

Commenters agreed that EPA's rationale for the five-year growth projections utilized in developing the proposed regulations was not valid. Another stated that industry should have confidence that investment in pollution control programs should be adequate for at least ten years.

Response:

In the proposal EPA contended that maintenance considerations were best addressed through maximum utilization of local input through on-going regional planning processes (generally Federally funded metropolitan planning organizations) with overall coordination by the Ohio Environmental Protection Agency. In response to the public comment, and for other reasons addressed in Section VII, EPA utilized ten-year growth projections in developing the promulgated regulations. This is consistent with the minimum requirement of the regulations for air quality maintenance (40 CFR 51; subpart D).

Comment:

Several commenters criticized a number of technical assumptions behind EPA's projections of future emissions. Commenters stated that the parameters value added, population and employment were poor indicators for EPA to use to forecast future emissions, due to two implicit assumptions: 1) that technology will remain constant over the projection years; and 2) that emissions are proportional to output. Another commenter pointed out that a wide variety of industries comprise the industrial categories represented by two-digit SIC codes ant that the EPA methodology assumed that the composition of the industrial categories would not change over the projection years. Lastly, one commenter pointed out that the data used to develop the growth projections did not take into consideration the "oil boycott" years, and asked that EPA provide further justification for the selection of the data base years.

Response:

Section VI, pertaining to growth projections, describes EPA's methodology in detail and addresses the criticisms.

6. Modelling and Methodology

Comment:

A number of commenters objected to EPA's use of dispersion modeling to predict air quality for areas where no ambient monitoring data exists or where monitoring data exists but no base year violations were observed. These comments state that EPA should not promulgate regulations for sources in such areas since the existing air quality data indicated that regulations are not necessary to assure attainment and maintenance of the NAAQS.

Response:

In the TSD to the proposed rulemaking EPA explained the need to use dispersion modelling methodologies: First, monitored air data represents only a sample of actual air quality in terms of both location and time. Second, the use of models is necessary to predict air quality under potential future source operating and growth conditions. At present, dispersion modelling is the best method available to predict future air quality concentrations and concomitantly the need for control. In an effort to reliably assure attainment and maintenance of the NAAQS (or protection of the PSD increments) EPA must regulate where valid modelling results project future NAAQS-PSD violations. The use of models in control strategy development is supported in the record by comments from utility, industrial and control agency representatives.

Comment:

Numerous commenters objected to the modelling assumption of simultaneous occurrence of a number of "worst case conditions" in addressing the 24-hour SO_2 standard, arguing that it is unrealistic and results in regulations which are more stringent than necessary to meet EPA's objective of assuring attainment and maintenance of the NAAQS.

Response:

Design or maximum load operating rates have been used with dispersion estimates to determine appropriate SO_2 emission limits for Ohio power plants. Alternative approaches to modeling power plant operations and selecting emission limits have been proposed. These alternatives suggest the use of actual hourly operating rates, or nominal load data rather than maximum load data. The following discussion assesses the usefulness of both nominal and maximum load in determining emission limits.

Nominal Load

Two approaches to the modeling of nominal load operations have been proposed for the Ohio power Plants: (1) the air quality impact of the plant is modeled using estimates of emissions developed from actual hourly generation data for a reference calendar year together with hourly meteorological data for the reference year, or (2) the hourly generation data for twenty (20) days from each of several years are selected. In this latter approach, the 20 calendar days associated with the-20 highest concentrations as determined by the maximum load simulations are recorded. Then the hourly generation data associated with these

20 calendar days in each of several years are determined. (Note that the same 20 calendar days are chosen in each year). The air quality impact of the plant is determined by modelling these "20 days" using the meteorological conditions for the same calendar days in the reference year.

The motivation for both of these approaches would seem to be an attempt to simulate the actual plant operating characteristics and the interaction between these operations and meteorological conditions. Although these approaches are appropriate for an historical examination of the air quality impact of a particular plant, they present some significant problems if used to determine emission limits.

Some implicit assumptions must be recognized when the hourly generation data for a reference year and the hourly meteorological conditions from the same year, or some other calendar year, are used to determine emission limits. The most critical implication of this approach is that this particular combination of plant operating characteristics and meteorological conditions is fixed in time. Obviously, this is not the case. In order to adequately simulate the interaction of plant operating conditions and meteorological conditions for the life of the plant, the hourly generation data must be modeled with many years of meteorological data, a procedure which is extremely time and resource intensive. One must also assume that the plant operating data reflect the future operation of the facility.

Another potential problem with the use of hourly generation data is the question of missing data, due to instrument malfunctions or abnormal plant operations. The implication of not including these days in the modeling analysis is that the plant is always "down" on these calendar days. Again, this is not a reasonable assumption. Also, suppose the worst meteorological conditions, from a dispersion viewpoint, happened to occur on a day with missing generation data: there would be no impact from the plant as determined by the model.

Selecting the plant generation data for 20 days from several years has similar problems. In this case, the operating conditions vary from year to year, but the "day of the year" is fixed. The 20 calendar days represent the 20 highest concentration days from the maximum load concentration estimates, thereby isolating the "worst" meterological conditions for the year. By selecting the same 20 calendar days for the plant generation data from each year, the relationship of plant operations to meteorological conditions is again assumed to be fixed. Also, having selected these calendar dates, it is conceivable that an examination of the hourly generation data will reveal missing data, days when the plant is down, or that the plant was operating at less than its "normal" load. In this situation, it is likely that some days not included in the analysis would yield higher concentrations.

There are several important technical considerations which must be addressed in either nominal load approach. If hourly plant generation data are used, then, logically, hourly coal sulfur content data should also be used to derive hourly plant emissions. Also, care must be taken to use the stack gas temperature and flow rate associated with the given level of plant operation. These data, however, are ususally not available.

Maximum or Design Load

Maximum or design load operations have been used to determine emission limitations for power plants in Ohio. The use of the emission rate associated with maximum load operations in modeling to determine emission limits offers several positive features. If it is assumed that the meteorological data for a given calendar year are representative of the range of meteorological regimes in the area, then meteorological data from only one year are required to determine the air quality impact of the facility. This provides, perhaps, the strongest motivation for using maximum load modeling procedures. With this assumption the uncertainties in the joint probabilities of meteorological conditions and plant operation arising from the use of only one year's meteorological data have been avoided.

Other advantages of the maximum load approach include: (1) enforceability - it avoids the enforcement problem of guaranteeing that the plant operates below some specified level, (2) it protects against the impact of the plant during maximum load operations, (3) it avoids problems encountered whenever plant operation data are missing, due to equipment malfunctions, or plant operations, and (4) it avoids technical problems of determining the appropriate emissions rate and the appropriate stack gas temperature and flow rate associated with the varying levels of plant operation.

One argument commonly stated for not using maximum load emissions in estimating the air quality impact of the facility is that "average plant operating rates are much less than design load." These statistics are usually presented as annual average operating rates, which tend to obscure the real issue. The question is, "How many days during the year does the plant operate at or near maximum load?" Because the primary concern is the second highest 24-hour concentration, any comparison of plant operating rates must be on a daily basis. Annual fuel use rates can be misleading. For example, if a peaking boiler presents a control problem for the facility, the issue is the daily fuel use rate and the number of times the boiler comes on line, not the annual fuel use rate, which, in this case, will be very low.

The argument usually expressed for not using maximum load operating rates to determine emission limits is that "maximum load is too restrictive--it greatly overstates the air quality impact of the plant." To address this issue, both maximum and nominal load operating rates have been used to estimate the air quality impace of six Ohio power plants: Poston, Muskingum, Conesville, Stuart, Cardinal, and Kyger Creek. The nominal load simulations for this analysis utilize a third approach to modeling nominal load operations. That is, a monthly emissions rate is estimated based on the monthly coal consumption and coal sulfur content data for each month. Stack parameters, appropriate for each level of plant operation, are determined. The choice of this approach for modeling nominal load operating rates in order to determine emission limits is based on its use of a complete, consistent set of data and its ability to average, or smooth out, the daily fluctuations in plant operations.

An analysis of second highest concentrations for the six plants reveals that (1) In contrast to earlier concerns, the maximum load approach does not greatly overestimate the second highest concentrations. In fact, for all but one plant, Stuart, using maximum load operating rates yields second highest concentrations which are lower than those determined for nominal load. (2) Significantly lower emissions for nominal load, due to boiler maintenance activities, explains the difference at the Stuart Plant. (3) In five of the six cases, the second highest concentration for the nominal load case occurred on either the same day or a day with similar meteorological conditions as the maximum load case.

Conclusions

The issue of using design or maximum load versus nominal load plant operating rates in determining emission limits for Ohio power plants has been addressed.

Two proposed nominal load approaches, (1) use of hourly generation data for an entire calendar year, or (2) use of hourly generation data for 20 days from several years have been evaluated. Although each of these approaches can be used to examine the historical air quality impact of the plant, they should not be used to determine emission limits. This conclusion is based on limitations associated with both nominal load approaches as follows:

1. Use of hourly generation and meteorological data for a reference year implies that the relationship between plant operation and meteorological conditions is fixed in time. This is obviously an unrealistic assumption.

2. There is no air quality impact from the plant (as modeled) whenever plant generation data is missing. If these data were missing on the day with the "worst" meteorological conditions, from a dispersion viewpoint, the impact of the plant and appropriate emission limts could be grossly underestimated.

3. To be consistent, if hourly generation data are used to derive emission rates, then hourly coal sulfur content data should also be used for this calculation. Also, hourly data on stack gas flow rate and stack gas temperature are required. Typically, these data are not available.

4. To adequately evaluate the interaction of plant operations and meteorological conditions with hourly data, requires many years of meteorological data and extensive analyses.

The advantages of using design or maximum load operating rates to determine emission limits are identified as:

1. One year of meteorological data may be adequate to determine the interaction between plant operations and meteorological conditions;

2. Enforceability;

3. Missing plant generation data does not affect the analysis;

4. Hourly coal sulfur data and hourly stack parameter values are not required.

For regulatory purposes, therefore, the use of design, or maximum load operating rates, in modelling to determine emission limits offers a reasonable, consistent, and conceptually sound approach.

Comment:

A number of commenters identified errors in specific data values used as inputs to the various models. The scope of these comments covered meteorological data, emissions data and air quality data. Also, commenters and participants in the public hearings submitted large amounts of data previously unavailable to EPA.

Response:

EPA untertook a detailed reassessment of the overall data base. This data base reassessment is described in Section II of the final Technical Support Document. The data base utilized in developing the promulgated regulations appears in the Appendices. In this county-by-county reevaluation, EPA has used the most complete, accurate data base available.

Use of a 100 ug/m³ concentration as 24-hour background for most rural areas was widely criticized. This value was determined by EPA utilizing detailed data which was available for only three counties. The value was criticized as being unrealistically high for many counties, and it was recommended that EPA carefully reevaluate the rural 24-hour background.

For example, the following points were raised at the public hearings:

(a) Were 1973 and 1974 representative years meteorologically?

(b) Why was the average of the top three backgrounds, determined from ambient data around utilities, used to represent the background?

(c) USEPA failed to relate specific county backgrounds in light of existing air quality, terrain, meteorology, and interaction of multiple point sources. Low level emissions may have impacted the monitoring sites.

(d) Are the 2nd maximum upwind air quality values representative of background for plants with air quality available? Can these values represent other plants?

(e) The USEPA discussion demonstrated no objective criteria or described adequately the methodology.

Response:

EPA undertook a detailed reevaluation of the 24-hour background. Data submitted during the public comment period used in conjunction with previously available data, provided a basis for determining background concentrations on a county-specific basis. Several methodologies were employed to offset limited data availability in some areas. The methodology and results of this reevaluation are described in Section II.

Comment:

Several commenters stated that the 24-hour model, MAX-24, should be calibrated against actual air quality data wherever such data are available.

Response:

Calibration of the MAX-24 model and short term models in general was discussed in some detail during the public hearings in Columbus on January 13th and 14th, 1976. When hour-by-hour model estimates are compared with observed concentrations, a shotgun scatter of data points is obtained. Part of this is a result of the fact that the meteorological data do not always reflect how a plume is transported from a particular source to a particular receptor. While meteorological data may indicate that the plume is affecting a sampling site, it may not do so in reality because of possible wind direction change with elevation. The extensive facility specific data base which would be necessary for model calibrations simply does not exist. The MAX-24 model was designed for uncalibrated use and therefore the lack of data for calibration does not invalidate its use. It should be pointed out, however, that the MAX-24 model has been evaluated and validated before it was utilized in the Ohio SO_2 rulemaking.

Comment:

Various commenters questioned the general validity of the MAX-24 methodology. Several questioned EPA's method of adjusting physical stack height to account for terrain features as well as the applicability of MAX-24 in urban areas. Also, a number of commenters stated that it was inappropriate to use the maximum MAX-24 prediction, instead of the appropriate second-maximum value, to develop emission limits.

Response:

The methodologies used by EPA on the final rulemaking obviate these objections. The promulgated regulations are based upon the projected impact of sources at receptor locations whose elevations were set receptor by receptor using reading from United States Geological Survey maps rather than a uniform adjustment. The MAX-24 model had been used in urban areas in the proposal as a cross check for emission limits developed based on the annual CDM urban model. For the final rulemaking a short term model, RAM, was specifically developed as a multiple source urban model employing dispersion coefficients appropriate to an urban area. This model is more fully discussed in Section IX of the final TSD. In response to the third objection, EPA reprogrammed the MAX-24 model to predict second maximum concentrations. In all cases where the 24-hour standard was determined to be critical, the promulgated regulations were based on the appropriate second-maximum concentration consistent with agency policy regarding interpretation of the 24-hour standard.

Comment:

Several commenters stated that precipitation, "lake breeze," frontal passages and terrain were not considered in the Cleveland and Toledo areas.

Response:

Although local wind regimes induced by a lake or a shore line may have significant influence on air pollutant dispersion, presently available atmospheric dispersion models have not progressed far enough to adequately address fumigation and plume trapping due to lake breeze flow. Further research and development in the area of quantifying the effects of lake flow on pollutant dispersion are required before such models can be utilized for rulemaking purposes. It should be noted, however, that, even though the models employed in the Cleveland and Toledo metropolitan areas did not account for lake breeze dispersion, the meteorological data input to these models reasonably reflect the meteorology of the area being modeled. With regards to the question of representative flow in the Cuyahoga Valley a number of potential flow studies accounting for the valley terrain were made by NASA with the conclusion that the terrain effects encountered in the valley did not significantly affect (small wind deflection) the wind flow in the area. EPA has determined that the best available data and methodology was employed in the analysis of the Cleveland and Toledo areas.

Comment:

Several commenters noted that EPA in several instances erroneously assumed 100% conversion of sulfur into SO_2 for coal combustion.

Response:

the appropriate conversion factor is 95%, as the comments indicated, and this factor was used in developing the final regulations.

Comment:

The schemes of Pasquill and Turner were criticized for consistently over estimating stability.

Response:

The system of classifying stability on an hourly basis based on airport observations was first developed by Dr. F. Pasquill of the British Meteorological Office in 1961. In 1964, D. B. Turner added objective criteria for estimation of stability class as a function of net radiation and wind speed. Although there are other schemes for stability classification this method has been the most accepted and widely used criteria in setting up a meteorological data base for dispersion modeling purposes. It should be noted, however, that stability classification by this method in and urban area is complicated by the urban heat island and, if the proper adjustments are not made to the classification system, the stability assigned is often over-estimated (more stable). All the models utilized in the urban areas for the proposal and final rulemaking corrected for thermal heat island effects on stability by proper adjustments on the classification system (CDM) or by utilization of urban dispersion coefficients (RAM).

Comment:

Several commenters questioned the use of a four hour SO_2 half life.

Response:

Numerous studies have been conducted for determining a representative SO_2 residence time (half-time). Residence times have varied from a few minutes to several days, with a few hours being the most supportable thus far. The factors which tend to transform pollutants physically or chemically after they are released to the atmosphere or to remove them from air are not clearly understood. However, the investigations conducted have been able to quantify variables which influence SO_2 residence time to the point of permitting the support of the use of 4 hour half-life as the most representative half-life for the general case.

Comment:

It was stated in several comments that pollutants do not conform to a Gaussian Plume as assumed by EPA's models.

Response:

The Gaussian distribution has been assumed for a continuous diffusion since 1932 by Sutton, 1953 Frenkiel, and many other workers. Lin and Reid (1963) pointed out that for very small diffusion times the distribution of particles should take the same form as the wind-fluctuation distribution since the particle trajectories coincide with the instantaneous wind; in the atmosphere this approximates a Gaussian distribution fairly closely. Moreover, experimental diffusion studies by Hay and Pasquill (1957), Cramer, Record, and Vaughan (1958), and Barad and Haugen (1959) indicate that the Gaussian plume formula should have a wide area of practical applicability in the atmosphere. Numerous publications can be cited that reference and recommend the basic Gaussian equation. The majority of all atmospheric dispersion models are based on the Gaussian plume assumption which form the basis for the EPA models used in the rulemaking.

Comment:

EPA's use of the proportional rollback model was criticized as being generally inadequate to determine needed emission reductions for a number of reasons, including:

The second technique, that of scaling from annual air quality data, which is used by Enviroplan to evaluate the background concentration at the Stuart, Ashtabula, Gavin, Burger, and other power plants, has two significant shortcomings. First, the technique of estimating a 24-hour background concentration by scaling the annual average value does not account for the effects of source distribution. The background concentrations are due to sources which are generally distributed rather unevenly across the countryside. As a result, some wind direction and stabilities result in high background concentrations, while others result in low background concentrations, under otherwise similar conditions. As a result, on the day of highest or second highest concentration, the amount of the background can be significantly affected by the wind directions, stability, and sampler locations relative to the distribution of sources.

Second, the scaling procedure depends on background concentration being approximately proportional either to 1/LU or to 1/U, where U is the wind speed and L is the mixing height. This is true only when the stability remains constant, since concentration, is highly sensitive to stability. Although stability is sometimes constant for the 24-hour periods of the highest modeled 24-hour concentration, it is not always so. In addition, the annual concentrations are a product of a mix of all stability classes.

In many instances, high background concentrations occur, not at the hours of the greatest impact from the plant, but a few hours earlier or later under different stability and wind conditions. The Enviroplan approach does not account for this at all.

1) Correct use of rollback requires a proportional reduction of emission at all sources.

2) The model does not consider such factors as spatial distribution of sources, stack height and terrain and that 40 CFR 51.13(e)(2)(ii) prohibits the use of rollback.

Response:

When an area was not able to be modeled with a mathematical dispersion model, the modified rollback model was used to develop regulations. The modified rollback model is an expanded version of the proportional, or simple, rollback model. It has the added advantages of being able to address effects of regulations on specific sources or categories of sulfur dioxide sources. Because of this feature, regulations for separate emissions sources such as boilers or processes can be developed. The sum of the reductions for all the individual sources or categories must, however, provide for the overall reduction required in the study area.

40 CFR 51.13 (e)(2)(ii) does not prohibit the use of rollback for developing regulations, but indicates that there are various parameters which must be subjectively evaluated since there is no capability to input these directly into the equation specified in 40 CFR 51.13(e)(2)(i). However, the modified rollback model which is an expanded version of the model specified in 40 CFR 51.13(e)(2)(i), and which was in fact used in the development of these regulations does have the capability to handle stack height and the spatial distribution of sources. Terrain features are not specifically considered other than to assume that the topography of the study area will not change significantly over the period of study. The technical support document, Section IX, discusses why neither the stack height nor the spatial distribution of sources was considered in the technical application of the model.

Comment:

One commenter noted that EPA did not consider the impact of potential future reductions of SO_2 emissions from sources located in West Virginia when performing the analysis of Jefferson and Belmont Counties:

Response:

A sulfur dioxide emission inventory was obtained from the State of West Virginia Air Pollution Control Commission. This inventory summarized emissions from sources in the base year as well as the future. Future year emission reflected compliance with applicable standards and the projected level of operation of the prospective sources. These data were used in the application of the technical procedures for both the Jefferson and Belmont counties regulation development effort.

Comment:

Enviroplan, Inc. used two techniques to estimate background concentrations around the Ohio power plants. The first technique - applied to the Backjord, Conesville and Philo plants - uses available monitoring data and meteorological data near the plant. This technique is one of selective exclusion of hourly air quality data and involves the use of those air quality data taken during the 10 days of highest measured concentrations, and excluding air quality data having any significant impact from the plant. The second technique - applied to the Stuart, Ashtabula, Gavin, Burger, and other power plants - makes use of the annual average concentrations from available measured data. This is a scaling technique. A scaling factor is applied to the annual average to obtain the estimated background for the period of maximum concentration from the plant. The adequacy of these techniques for estimating background concentrations is assessed below.

Response:

The first technique, that of selective exclusion of hourly air quality data, (which is used by Enviroplan Inc., to estimate background at the Beckjord, Conesville, and Philo plants), is not valid for two reasons. First, a very large portion of the monitoring data - 75 percent to 97 percent at the above named plants - are excluded from the analysis, leaving too few data for a statistically valid sample. Second, air quality measurements taken when the winds are light are selectively excluded from the analysis by placing a restriction on plume travel time. This tends to bias the results.

In order to obtain a valid estimate of background from the measured air quality data, it is necessary, first, to exclude pollutant concentrations at those sites which are affected by the plant being studied. The average of pollutant concentrations at all sites which are not affected by the plant represents a reasonable estimate of the background for that hour.

To do this, the Enviroplan technique excludes from the background estimate any air quality data measured within ±45 degrees of the downwind direction from the plant. The downwind direction is determined by wind measurements at the plant. This is a reasonable procedure for excluding the air quality data affected by the plant. An average of the remaining air quality data from other sides for that hour should give a reasonable estimate of the "background." However, Enviroplan additionally excludes all air quality data from a sampler for any day during which that sampler is within ±45 degrees of the downwind direction from the plant for less than two hours. That is, the air quality data from a given receptor at a given hour is retained for background computations provided the wind does not blow the plume to within 45 degrees of the sampler for at least two other hours in that day. This last procedure results in the greatest exclusion of air quality data from the background analysis. Any benefit that might be gained from that procedure is more than offset by errors introduced by the sizable reduction in the amount of air quality data retained for the background analysis.

The travel time restriction excludes all air quality data for cases when the wind speed is below some critical value; this value depends only on the distance of the sampler from the plant. For example, at the Philo plant, all air quality data collected when winds are less than the critical speed listed below are excluded in the Enviroplan background analysis:

Sampler	Distance (km)	Critical (mps)	Wind Speed (knots)
Philo	1.710	2.85	5.54
Fox Run	4.839	8.06	15.68
Irish Ridge	4.981	8.30	16.14
Duncan Falls	1.319	2.20	7.13
Salt Creek	5.955	9.92	19.29
Indian Run	4.214	7.02	13.65

Since "background" concentrations - especially the portions due to the more distance sources - are approximately proportional to the inverse of the wind speed (1/U), this procedure tends to exclude cases with high background concentrations. This bias makes the technique unacceptable.

The effects of the exclusion of so much data from the background calculations can be seen from the application of the technique to the Beckjord, Conesville, and Philo plants. For example, the days on which the Beckjord and Conesville plants are expected to produce their highest concentrations are not represented in the background calculations. In addition, no complete 24-hour period is represented at any of the plants. Also, at the Conesville plant, the early morning hours are represented five times more often than the late evening hours.

In conclusion, both techniques that are used by Enviroplan to estimate background concentrations around single point sources have significant shortcomings. This causes doubt in the validity of background estimates determined with these techniques. EPA's methodology for assessing background concentrations are discussed in Section II of the technical support document.

Comment:

Missing Air Quality Data

Many written comments contained references to actual air quality numbers which are not contained in the technical support document.

Response:

Although only 13 of the papers contained lists of sites with summary statistics, raw data, locations and, in some cases, maps, most major industrial plants or utilities, having fairly substantial networks, included some helpful information on the actual site locations and the sampling methodology. Many plants did not reveal quality assurance information on the actual site locations and the sampling methodology. Many plants did not reveal quality assurance information although referenced Federal Register methodology was sufficient documentation of the procedures. All data available for 1973 and 1974 were reviewed and are summarized in Appendix G.

Comment:

A topic receiving considerable comment was the reference to incorrect data in the technical support document. Specific areas in question were Dayton, Cincinnati, Butler County, Stark County, Toledo, Trumbull County, and Mahoning County. In Cincinnati one singularly important issue concerned using a partial year of continuous data to represent the maximum annual average in the proportional model.

Response:

All data were reviewed carefully for methodology and sampling criteria. All reference to government collected data by industry were tabulated and compared to OEPA's document "Sulfur Dioxide Concentrations for the State of Ohio 1972-1974", the National Aerometric Data Bank, and the most current SO_2 "validated" data base submitted to USEPA by OEPA subsequent to the Ohio Public Hearing. In the final analysis, for Cincinnati, a full year of continuous air quality data was evaluated before use in developing the final regulations for promulgation.

Comment:

Air monitoring data quality assurance issues were raised. One issue stated that USEPA should not have considered using data collected by local agencies since it is "almost universally of poorer quality than the national data". A second comment indicated that the conductimetric monitoring method is not valid but the data were used in calibrating the Climatological Dispersion Model (CDM) in Toledo. Thirdly, continuous methods and the Federal reference method (FRM) bubbler methodologies do not correlate well; the validity of air quality data by the reference method used in preparing the regulations may be questionable if the quality assurance procedures are not strictly followed. This especially referred to temperature effects on the FRM.

Response:

The role of the local agencies concerning air monitoring has been specified in the Clean Air Act under Section 51.21, Intergovernmental Cooperation. As mentioned in Section II of this technical support document, each USEPA funded agency is routinely surveyed for conformance with Federal Register approved monitoring techniques. The conductimetric method can be used for the purpose of establishing the control strategy for sulfur dioxide as referenced under 40 CFR 51.13. Various documents have pointed out the differences of the continuous versus bubbler methods; both are currently acceptable for planning purposes. However, this SO_2 monitoring issue is currently under review by USEPA and future monitoring methods and siting objectives may be published in the Federal Register.

Finally, the issue concerning the temperature effect on the FRM-SO_2 method was reviewed. USEPA requested that (1) a review be made by each State and local agency of both the collection of samples and analysis by the method specifically used and (2) a review of the past data where there might have been sample degration. Special attention was given to (a) each site where thermal exposure of the bubbler box would be excessive (over 30 degrees C), (b) the type of temperature control (if any) on the bubbler box (thermostat or timed), (3) transport of the samples, (4) sample storage conditions before analysis, and (5) time lag between sampling and analysis. Review of past data could be limited to those sites with uncontrolled temperature conditions when the concentration exceeded 150 ug/m^3.

All agencies have thermostats with heaters with RAPCA and Portsmouth having sites in environmentally controlled rooms. Most samplers are on roof tops exposed to temperatures greater than 30 degrees C; however, most are contained in shelters with some insulation from direct sunlight. Ohio EPA suggested placing bubblers in air conditioned environments if at all possible, and when danger of freezing has been eliminated, the heater should be disconnected. Most agencies collect the samples within a day after sampling, and storage temperature is usually at 40 degrees

F excepting Akron which stores at 22 degrees C (room temperature).

The impact of the problem on data exceeding 150 ug/m³ seems to be minimal. The Lake County Agency revealed that on four sampling days when temperatures exceeded 30 degrees C, the SO_2 results from most of these stations were over 150 ug/m³; however, historically the second maximum 24-hour values at sites in Lake County have ranged from 87.1 ug/m³ to 164.3 ug/m³ at other than "source oriented" sites. This issue also is currently under further review by USEPA.

7. Economic Feasibility

Comment:

A large number of commenters addressed in one way or another the costs of compliance with the proposed regulations and the potential economic impacts associated with those costs. Among the commenters were individual citizens, environmental groups, chamber of commerce organizations, elected officials, representatives of the pollution control industry and regulated industries. The submitted comments covered a wide variety of topics including potential loss of jobs, potential gain of jobs, plant closings, real economic growth in the pollution control industry, unfair burden on large sources vs. small sources, utility rate increases, product price increases, capital shortages and other shortages, reduced medical expenses, reduction in pollution damage to crops, animals and structures (i.e. welfare effects) and more.

Response:

At least three important conclusions related to economics can be drawn from the information appearing in the public record.

(1) The public and the regulated industries have expressed a general willingness to pay the costs associated with regulations which are shown to be necessary to protect the public health and welfare (i.e. the SO_2 NAAQS);

(2) Both favorable and unfavorable economic effects result from the implementation of pollution control regulations;

(3) For each individual source, the technological feasibility of implementing a compliance program to meet a specific emission limit is directly related to its economic feasibility at the source.

It is important to note EPA's obligations under the Clean Air Act (Section 110). As EPA pointed out in the Technical Support Document to the proposed rulemaking, one of the major objectives of the act (Section 110) is attainment and maintenance of the NAAQS (through reduction of pollutant emissions), which are designed to protect the public health and welfare. The principal criteria, therefore, utilized by EPA in developing the regulations for promulgation under Section 110 was their effectiveness in assuring attainment and maintenance of the standards through the emission limitations and reductions which will result from their implementation.

The legislative history of the Act suggests that the cost of reducing emissions were not to be considered an impediment to achieving the NAAQS (Sec. 116 Cong. Rec. 32901). This was recently confirmed by the decision of the Supreme Court of the United States (Union Electric Co. vs. Environmental Protection Agency et al. (No. 74-1542)), which affirmed that the EPA, in approving implementation plans developed by the states, must limit its consideration to the factors enumerated in Section 110, which factors do not include economic considerations.

Although the Court specifically declined to indicate the extent to which economics would need to be considered when EPA promulgates a plan, it is EPA's view that in any event the plan must attain and maintain the NAAQS.

In response to the public's concern over the potential adverse economic impacts of the proposal, and because EPA firmly believes that environmental objectives should be accomplished with as little adverse economic impact as practical, EPA utilized a methodology in developing the promulgation which enabled the agency flexibility to select emission limitations on a source category basis which are generally achievable through current proven technology. In employing the revised methodology, EPA minimized adverse economic impact to the maximum extent practical by ensuring that the promulgated regulations are no more stringent than necessary to assure attainment and maintenance of the standards. Also, the methodology allows certain isolated sources to select the least cost mix of emission limitations for their facilities.

As a result of EPA's revised methodology, few sources will be challenged by the "technology forcing" aspects of the Clean Air Act since the promulgated emission limitations have been demonstrated achievable with current, proven technology on sources similar to those being regulated in Ohio. The fact that similar emission limitations have been achieved elsewhere on retrofitted sources attests to the general feasibility of the final requirements.

REFERENCES

1. Review of the U.S. EPA Region V Office's Proposed SO_2 Emission Standards and a Description of Alternative SO_2 Control Programs for Achieving SO_2 Air Quality Standards in a More Economically Efficient Manner. Ashtabula Power Plant, Enviroplan, Inc., January 1976.
2. Ohio Power Co. Exhibit No. 10. Philo Power Plant, Enviroplan, Inc., January 1976.

SECTION II

DATA BASE

Section II. DATA BASE

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SECTION II. DATA BASE

A. Emission Inventory Data Base

INTRODUCTION

This part of the technical support document describes the various input data and their sources, which were applied in the development of the SO_2 control strategy. Within this portion of the support document, the emissions data are addressed first, followed by an assessment and analysis of the air quality data, a discussion of the meteorological data and finally, a discussion of procedures for determination of 24-hour SO_2 air quality background concentrations. Actual data utilized in strategy development appears in the appendices.

1. Urban Area Emission Inventory Collection

a. Cleveland

The Cleveland urban area analysis encompassed the counties of Cuyahoga, Lake and Lorain. The source inventory was developed by PEDCo Environmental Specialists, Columbus, Ohio under contract to the USEPA. The emission data used in the analysis was compiled from Ohio EPA Emission Inventory Reports and supplemented with information acquired through review of public comment, information requests under the authority of Section 114 of the Clean Air Act sent to specific point sources and telephone conversations with OEPA and source representatives.

The following is a list of sources from whom information was received to confirm and correct the data base, either via telephone conversation or Section 114 requests, since the public hearings were held on the proposed regulation (40 FR 52410):

Addressograph	
Allied Chemical	
Cleveland Pumping	
Diamond Shamrock	
Ford Motor Company	(Section 114 Request)
General Electric	
General Motors Corporation	
Lubrizol Corp.	
National Lead	
Painesville Municipal	
Republic Steel Corporation	
Uniroyal	
U.S. Steel Corporation	(Section 114 Request)

In addition to the aforementioned information sources, data for the following Cleveland Electric Illuminating Company facilities was obtained from company furnished reports prepared by EnviroPlan, Inc. and Federal Power Comission Forms 67.

CEI - Canal Road
CEI - Eastlake
CEI - Hamilton
CEI - Lakeshore

The area source emissions inventory for the Cleveland (as well as Youngstown, Dayton, Steubenville and Cincinnati) area was assembled by PEDCo Environmental Specialists, Inc. The foundation for the area source emissions inventory are U.S. Bureau of Mines statewide fuel use totals for Ohio. Using the techniques outlined in "Guide for Compiling a Comprehensive Emission Inventory" (APTD-1135), March 1973) emissions were apportioned to counties. The area source categories utilized are listed in Table 1. The county totals resulting from the apportioning procedures were cross-checked by contact with fuel dealers and supporting air pollution control agencies. Aviation related data was obtained by direct contact with airport officials. Subsequently, CAASE (Computer Assisted Area Source Emission Gridding Procedure, EPA-450/ 4-74-009) was used to apportion the total emissions calculated on a county basis to smaller geographic units within the county. This sub-county distribution of emission into pre-selected grid squares is required to accurately represent the area source inventory. CAASE calculates emissions for each grid square from the previously mentioned fuel consumption data. CAASE output data is formulated on computer cards for input to CDM. The apportioning of emissions from the county level was performed by assigning objective apportioning factors (factors based on population units, grid square area, etc.). The year of record for point and area source data used in the emission inventory is 1973.

Table 1. AREA SOURCE EMISSION CATEGORIES

CATEGORY NUMBER	MAJOR CLASSIFICATION	MINOR CLASSIFICATION	OBJECTIVE APPORTIONING FACTOR
1	Residential fuel	Anth. Coal	Housing Units
2	Residential fuel	Bitum. Coal	Housing Units
3	Residential fuel	Dist. Oil	Housing Units
4	Residential fuel	Nat. Gas.	Housing Units
5	Residential fuel	Wood	Housing Units
6	Comm'l & Institl fl.	Bitm. Coal	Population
7	Comm'l & Institl fl.	Dist. Oil	Population
8	Comm'l & Institl fl.	Resid. Oil	Population
9	Comm'l & Institl fl.	Nat. Gas	Population
10	Industrial fuel	Bitum. Coal	Population
11	Industrial fuel	Dist. Oil	Population
12	Industrial fuel	Resid. Oil	Population
13	Industrial fuel	Nat. Gas	Population
14	On-Site Incineration	Residential	Housing Units
15	On-Site Incineration	Industrial	Population
16	On-Site Incineration	Comm'l & Instit'l	Population
17	Gasoline Fuel	Light Vehicle	Population
18	Gasoline Fuel	Heavy Vehicle	Population
19	Gasoline Fuel	Off Highway	1/Population Density
20	Diesel Fuel	Heavy Vehicle	Population
21	Diesel Fuel	Off Highway	1/Population Density
22	Diesel Fuel	Rail Locomotive	Grid Sq. Side Length
23	Aircraft	Military	Area
24	Aircraft	Civil	Area
25	Aircraft	Commercial	Area
26	Vessels	Diesel Oil	Grid Sq. Side Length
27	Vessels	Resid. Oil	Grid Sq. Side Length
28	Vessels	Gasoline	Grid Sq. Side Length

b. Toledo

The Toledo urban area analysis considered those sources located in Lucas County, a source in Wood County, which is under the jurisdiction of the Toledo Pollution Control Agency, and sources in the neighboring State of Michigan, from which plume interaction was expected. The source inventory was prepared by PEDCo Environmental Specialists under contract to the USEPA. Source specific information, such as stack parameters and emission rates were complied from Ohio Environmental Protection Agency Point Source Engineering Data Sheets.

Supplemental information was acquired under the authority of Section 114 of the Clean Air Act through information request, review of public comments, telephone conversations with source representatives and through a review of a GCA/Technology Division study performed under contract to the USEPA and specific to the Phillips Petroleum Philback Plant. Other companies about whom information was gathered as mentioned above were:

Goodyear

Libby Owens Ford

Toledo Edison

The only significant difference between the emissions data gathering and verification procedures used in the Toledo urbanized area and those procedures used in the Cleveland urbanized area involved gathering area source data. The USEPA, Region V provided gridded (using CAASE) area source emissions to TRC. The year of record of this data was 1970.

c. Akron

The Akron urban area analysis involved all sources located in Summit County. The original source inventory was developed by TRC under contract to the USEPA. This inventory changed very slightly between proposal and promulgation because of lack of any additional data for the base year 1973. The subsequent inventories for 1975 and the projection years were compiled by using data from a variety of organizations, and from the public comments submitted as a result of the November 10, 1975 public notice. Included as sources of information are: State of Ohio Emission Inventory Confirmation Reports and Point Source Engineering Data Sheets, USEPA Section 114 reports on file in the Region V Enforcement Division, and verbal communications with the Akron Regional Air Pollution Control Authority. Data for the Ohio Edison facility was obtained in port from the FPC form 67.

The only significant difference between the emissions data gathering and verification procedures used in the Akron urbanized area and those procedures used in the Cleveland urbanized area involved gathering area source data. The USEPA, Region V provided gridded (using CAASE) area source emission to TRC. The year of record of this data was 1970.

d. Cincinnati

Emission data in grams of SO_2 per second were obtained from State inventory compilation forms for Cincinnati in 1973. Data was classified by point source (i.e., individual common stacks) and further categorized by Standard Industrial Classification (sic) Codes, and by process or combustion sources where necessary. Rated capacity data in million BTU per hour were obtained from the Division of Air Pollution Control, City of Cincinnati. Emission limitations on fuel consumed in the base year was calculated from data listed on the State Inventory Compilation forms.

The area source emission inventory for Cincinnati was developed in the same manner as for Cleveland.

e. Youngstown (Mahoning County) and Warren (Trumbull County)

An emission inventory, base year 1974, was obtained from the Ohio Environmental Protection Agency. Information was obtained by SIC category as well as for each specific source category. Updates of this emission inventory were obtained from the Ohio EPA as recently as August 1976.

The area source emission inventory for Youngstown was developed in the same manner as described for Cleveland.

f. Steubenville (Jefferson and Belmont Counties)

An emission inventory, base year 1974, was obtained from the North Ohio Valley Air Authority (NOVAA). Information was obtained by SIC category as well as for each specific source category. Updates of this inventory were obtained from NOVAA as recently as August 1976. In addition, information on West Virginia emission sources were accounted for through an inventory provided by the West Virginia Air Pollution Control Commission.

The area source emission inventory for Steubenville was developed in the same manner as for Cleveland.

g. Canton

The Canton analysis included the point sources located in Stark County. The emission data used in this analysis was compiled from the Ohio EPA Emission Inventory Reports. This data base was supplemented and updated with information acquired through the Section 114 process and a review of the public comments received. Additionally, the Air Pollution Control Division, Department of Health, Canton, Ohio was contacted directly for verification of specific data.

h. Columbus

The Columbus analysis included all point sources located in Franklin County. The emission data used in this analysis was compiled from the Ohio EPA Emission Inventory Reports. This data base was supplemented and updated with information acquired through the Section 114 process and a review of the public comments received. Additionally, Ohio EPA was contacted directly for verification of specific data.

i. Dayton

The Dayton analysis included point and area sources in Montgomery County. The area source inventory was developed by PEDCo Environmental Specialists, Columbus, Ohio under contract to the USEPA. The point source emission inventory was compiled from the Ohio EPA Emission Inventory Confirmation Reports. This data base was supplemented and updated with information acquired through the Section 114 process and a review of the public comments received. Additionally, the Regional Air Pollution

Control Agency (RAPCA) was contacted directly for verification of the final point source inventory.

The area source emission inventory for Dayton was developed in the same manner as described for Cleveland.

2. Rural Area Emission Inventory Collection

The point source emissions data utilized in these areas was the data obtained through the Section 114 mechanism which is described below.

The Ohio SO_2 strategy development effort is being carried out by the USEPA, pursuant to Section 110 of the Clean Air Act, as amended, which requires the development of implementation plans to attain and maintain the NAAQS. Section 114 of the Act provides that, for the purpose of developing or assisting in the development of any implementation plan under Section 110 (and for other reasons), the Administrator may require the owner or operator of any emission source to maintain records, measure emissions, make reports, and provide such other information as he may require. Under the provision of Section 114 point source emissions data were compiled for thirty-two power plants representing eight private utility companies and four municipal utilities in the State of Ohio. The year of record for data received through this mechanism was 1973, with the exception of the Ohio Power Company Data, which were for the year 1971. In addition, the Section 114 mechanism was used to obtain data from approximately 109 industrial sources in non-urban Ohio areas.

To obtain the data utilizing the Section 114 mechanism, certified letters were sent to the utilities listed in Table 2 and to the industrial process and non-utility fuel combustion sources listed in Table 3. A sample Section 114 letter is shown as Table 4. If a response to the certified letters is not provided to the USEPA within a reasonable time period, a follow-up letter is sent. Non-respondents and persons providing erroneous data may be subject to penalties under the Clean Air Act. In some cases, recipients of the letters contacted the USEPA to obtain clarification of the data requests or to request an extension of the time allowed to provide the data. All reasonable requests were granted. In some cases, the USEPA contacted respondents to request clarification of the submitted data. In addition a number of sources and the state and local agencies were also contacted after the public comment period in order to verify additional data submitted.

Table 2. THIRTY-TWO OHIO POWERS PLANTS PROVIDING DATA THROUGH THE SECTION 114 MECHANISM

1. Poston
2. Beckjord
3. Ashtabula
4. Picway
5. Conesville
6. Mad River
7. Stuart
8. Philo
9. Muskingham River
10. Woodcock
11. Gavin
12. Kyger Creek
13. Piqua
14. Niles
15. Cleveland Municipal
16. Acme
17. Bayshore
18. Lake Shore
19. Tait
20. Hutchings
21. Avon Lake
22. East Lake
23. Sammis
24. Burger
25. Edgewater
26. Gorge
27. Toronto
28. Tidd
29. Cardinal
30. Miami Fort
31. Hamilton Municipal
32. Painesville Municipal

Table 3. SECTION 114 EMISSION INFORMATION REQUESTS TO NON-UTILITY POINT SOURCES

Counties	
Allen	Clark Equipment Co., 1000 S. Main St., Lima, Ohio 45802 Vistron Corp., P.O. Box 628, Lima, Ohio 45802 Standard Oil, 1150 S. Metcalf, Lima, Ohio 45804
Ashtabula	Cabot Titonia, Middle Road, Ashtabula, Ohio 44004
Franklin	American Zinc Co., 1363 Windsor Ave., Columbus, Ohio 43216 August Wagner Brewery 605 S. Trent, Columbus, Ohio 43206 Buckeye Steel Casting, 2211 Parsons, Columbus, Ohio 43207 Capital City Products, 525 W 1st Ave., Columbus, Ohio 43216 Col's Coated Fabrics, 1280 N. Grant Ave., Columbus, Ohio 43216 Defense Construction Supply Co., 3990 E. Broad St. Columbus, OH Jeffrey Mining Machinery Co., 274 E. First, Columbus, Ohio 43201 North American Rockwell Co., 4300 E. Fifth Aven., Columbus, OH
Washington	B. F. Goodrich Co., Box 657, Marietta, Ohio 45750 Union Carbide Ferroalloys, Box 299, Marietta, Ohio 45750
Tuscarawas	Reeves-Bowman, 137 Iron Avenue, Dover, Ohio 44622 Union Camp, 875 Marger, Dover, Ohio 44622
Wayne	College of Wooster, Wooster, Ohio 44691
Greene	Universal Atlas Cement, Dayton and Springfield, Fairborn, OH 45324 Southwest Portland Cement, 509 E Xemia, Fairborn, Ohio 45324 Central State University, Wiberforce, Ohio 45384 Wright-Patterson AFB, Ohio 45433
Ross	Mead Papers, 5 Point Street, Chillicothes, Ohio 45601

Table 3. (Cont.)

Stark	Babcock and Wilcox, 640 Keystone St., Alliance, Ohio 44601
	Babcock and Wilcox, 1561 Beeson St., Alliance, Ohio 44601
	Canton Drop Forge, 4575 S. Way Street, Canton, Ohio 44706
	Portjec Inc. Forgings, 2027 Deuber, Canton, Ohio 44706
	Republic Steel, 2633 8th Street, Canton, Ohio 44706
	Transue and Williams, 562 W. Fly St., Alliance, Ohio 44601
	Union Metal Mfg., 1432 Maple Avenue, Canton, Ohio 44705
Auglaize	St. Marys Muncipal Power Plant, P. O. Box 129, St. Marys, Oh 45885
Crawford	The Timkin Co., Beal Avenue, Bucyrus, Ohio 44820
Erie	Ford Motor Co., 3020 Tiffin Avenue, Sandusky, Ohio 44870
	New Departure-Hyatt, 2509 Haynes Avenue, Sandusky, Ohio 44870 44870
	New Departure-Hyatt, 2509 Haynes Avenue, Sandusky, Ohio 44870
Fairfield	Crown Zellerback, 210 Water Street, Baltimore, Ohio 43105
Hancock	Cooper Tire and Rubber, Lima and Western, Finley, Ohio 45840
Henry	Campbell Soup Company, Napoleon, Ohio 43545
Huron	Norwalk Muncipal Power, 201 Woodlawn Ave., Norwalk, Ohio 44857
Licking	Kaiser Aluminum and Chemical, Route 79 South, Newark, OH 43055
	Roper Corp., Newark Div., 550 Wehbre Avenue, Newark, OH 43055
Marion	Central Soya, 751 E. Farming St., Marion, Ohio 43302
Richland	G. M. Fisher Body Div., 2525 W. 4th, Mansfield, Ohio 44906
	Shelby Muncipal Light, Marsfield Ave., Shelby,

Table 3. (Cont.)

	Ohio 44875
Wood	Bowling Green State Univ., Bowling Green, Ohio 43403 Libby, Owens, Ford, Dixie Highway, Rossford, Ohio 43460
Miami	Troy Power Plant, Troy, Ohio 45373
Ottawa	U.S. Gypsum Co., Gypsum, Ohio 43433
Pickaway	Container Corp. of America, 401 W. Miller, Circleville, OH 43114
Pike	U.S. Atomic Energy Comm., Piketon, Ohio 45661
Hancock	Ashland Oil Co., Glessner St. Plant, Findlay, Ohio, P. O. Box 391
Richland	Ohio Brass Co., Mansfield, Ohio 44902
Ashtabula	Reactive Metals, P. O. Box 490, Ashtabula, Ohio 44004 Union Carbide Ferroalloy, Lake East, Ashtabula 34004
Wayne	Morton Salt, 151 Industrial Street, Rittman, Ohio 44270 Packaging Corp. of America, Industrial Street, Rittman, OH 44270
Hancock	Northern Ohio Sugar, Box 89, Findley, Ohio 45840
Franklin	Westinghouse Electric Co., Columbus, Ohio 43216 Capital University, Physical Plant, 2199 E. Main St., Columbus, City of Columbus, Div. of Electricity, 90 W Broad St. Muncipal Power Plant, Columbus, Ohio 43216 Dayton Malleable Iron Co., Ohio Mallcable Div. 1343 Fields Ave. Columbus, Ohio 43201 Marble Cliff Quarries Co., 2100 Tremont Center Columbus, OH 43221
Washington	Shell Chemical Co., P. O. Box 235, Belpre, Ohio 45714
Lawrence	Allied Chemical Co., Agricultural Div., South Port, Ohio (Mailing Address) P. O. Box 98 Ironton, Ohio 45638 Allied Chemical Co., Semet-Salvay Div., P. O. Box

Table 3. (Cont.)

	97 Ironton, Ohio 45638
Lawrence	Dayton Mallcable Iron, Inc., Ironton Plant, Ironton, OH
	Allied Chemical Co., Speciality Chemicals Div., Rte. 1 Box A South Point, Ohio 45680
	North American Refractories Co., 13th and Ashtabula Sts. Ironton, Ohio 45638
	Marquette Cement Mfg. Co., Superior Plant, P. O. Box 8 Pedro, Ohio 45659
Columbiana	East Palestine Municipal Electric Plant, 75 E. Main St. East Palestine, Ohio 44413
	Kaiser Refractories, Div. of Kaiser Aluminum $ Chemical Corp. P.-O. Box 47, Columbiana, Ohio 44408
Richland	Cyclops Corp., Empire-Detroit Steel Div., 913 Bowman St. Mansfield, Ohio 44901
	Westinghouse Electric Corp., Consumer Products, 246 E. 4th St. Mansfield, Ohio 44902
	Mansfield Tire and Rubber, 515 Newman, Mansfield, Ohio 44902
Tuscarawas	Dover Municipal Electric Plant, 303 E. Broadway, Dover, OH 44622
	Belden Brick Co., Sugarcreek, Ohio 44681
	Simonds Cutting Tools, Wallace Murray Corp. Newcomerstown, Ohio 43832
	Twin City Hospital, First and Fuhr, Dennison, OH 44621
	H. K. Porter Co., P. O. Box 309, Uhrichsville, Ohio 44683
Stark	Ford Motor Co., Canton Forge Plant, P. O. Box 8591, Canton, OH
	Superior Brand Meats, Southway St., P.O. Box 571, Massillon, OH 44646
	Timken Co., ¢ General Offices, 1835 Deuber Ave., S. W. Canton, Ohio 44706
	Ashland Oil Co., Canton Refinery, 2408 Gambrinus Rd. (Mailing Address) P. O. Box 350, Canton, Ohio 44706
Auglaize	Goodyear Tire and Rubber Co., South Wayne St. St. Marys, OH
	St. Marys Foundry Co., 405-409 E. Wouth St. St. Marys, OH 45885
Coshocton	St. Regis Paper Co., Coshocton Mill Div., Paper Mill

Table 3. (Cont.)

	Rd. Coshocton, Ohio 43812
Licking	Owens-Corning Fiberglass Plant, Cass Ave., Newark, OH 43055
Scioto	Cyclops Corp., Empire-Detroit Steel Div., P. O. Box 371
Seneca	Union Carbide Corp., Carbon Products Div., Town St., Fostoria, (mailing address) P. O. Box 191 Fostoria, Ohio 44836
Meigs	Excelsior Salt Works, Inc., 640 Main St., Pomeroy, Ohio 45769
Ashtabula	New Jersey Zinc Co., P. O. Box 160 Ashtubula, Ohio 44004 General Tire and Rubber Co., Ashtabula, Ohio 44004 Detrex Co., Ashtabula, Ohio 44004
Erie	Ford Motor Co., 3020 Tiffin Avenue, Sandusky, OH 43130
Fairfield	Fairfield School for Boys, Lancaster, Ohio 43130
Stark	Massillon State Hospital, 3000 Erie St., Massillon, OH 44646 Norfolk and Western R. R., N. Wabash Ave., Brewster, OH 44613
Huron	Liquid Disposal Co., R. D. #2, Norwalk, Ohio 44857
Marion	Marion Power Shovel Co., Inc., 617 W. Center St., Marion, OH 43302 Wyandot Blacktop Co., Inc., 1465 N. Main St., Marion, Ohio 43302
Summit	Ohio Brass Co., Park and Ninth St., Barberton, Ohio 44203 P. P. G. Industries, Chemical Div., P. O. Box 31, Barberton, OH 44203
Sandusky	Ohio Lime Co., Woodville, Ohio 43469 Woodville Lime and Chemical Co., Woodville, Ohio 43469 H. J. Heinz Co., 1200 N. Fifth, Fremont, Ohio 43420 Standard Lime and Refractories, Woodville, Ohio 43469

Table 3. (Cont.)

.	Muskingum	Burnham Corp., Foundry Div., Licking River Rd., P. O. Box 2398 Zanesville, Ohio 43701 Brockway Class Co., Zanesville, Ohio 43701
	Henry	Napoleon Power and Light, Riverview and Hly, Napoleon, OH 43545

Table 4. SAMPLE SECTION 114 LETTER WITH ATTACHMENTS

CERTIFIED MAIL

Dear Sir:

Under provisions of the Clean Air Act, as amended, (42 U.S.C. 1857 et. sec.), the Administrator of the United States Environmental Protection Agency (EPA) is required, under certain circumstances, to promulgate an implementation plan to attain the national ambient air quality standards with a state. EPA is in the process of promulgating such a plan in Ohio for the attainment and maintenance of the national ambient air quality standards for sulfur dioxide.

It has been determined that the information requested herein is necessary to the development of a sulfur dioxide implementation plan. Accordingly, you are required under authoriity of Section 114(a) of the Clean Air Act to report the information requested in the two attachments to this letter for the following facility:

The information required by this letter that applies to your facility, shall be submitted to Mr. James H. Conlon, Director, Air and Hazardous Materials Division, Environmental Protection Agency Region V, 230 South Dearborn Street, Chicago, Illinois 60604 no later than 15 days after receipt of this letter. The information should be accompanied by the name and phone number of a person who will be available to answer any questions regarding the data submitted. Any questions regarding the information required by this letter may be addressed to Mr. John Chicca of my staff (312) 353-6942.

Attachments

Attachment 1

Data Required for Industrial Boilers which Emit Sulfur Dioxide

A) Operating Characteristics

1. Identification of operating boilers and stacks for 1973 and 1974.

2. Locations of stacks (using Universal Transverse Mercator Coordinates-UTM).

3. Normal load and maximum hourly fuel consumption rate. State if the maximum hourly fuel consumption rate is a design rate or an experienced maximum rate (design rate is preferred).

4. Physical diameter and height above ground level of each stack.

5. The gas exit velocity and temperature for each stack with the boiler operating at normal and maximum fuel consumption conditions for 1973 and 1974.

6. A sketch of plant layout with the locations (relative to stacks) of all buildings surrounding the stacks, showing stack spacing and locations, and include approximate building heights.

B) Fuel Analysis for Use in Determining Sulfur Dioxide Emissions

If the following data is not readily available, please submit the name of the supplier and specify a person to contact who will be able to answer these questions on an as-supplied basis.

1. Average monthly sulfur content of fuel for 1973 and 1974.

2. Method used to determine the sulfur content of fuel.

3. Range of all sulfur content test results for 1973 and 1974.

4. Standard deviation of sulfur content for 1973 and 1974.

Attachment 1 (cont.)

C) Air Monitoring Data for All Monitors Near the Plant for Sulfur Dioxide

1. Location of each monitor operated in 1973 and/or 1974 (Universal Transverse Mercator Coordinates-UTM).

2. Sample collection method (i.e. bubbler or continuous) for each monitor.

3. Sampling schedules for each monitor.

4. Sample analysis method (West Gaeke colorimetric, coulometric, etc.) for each monitor.

5. For continuous sampling, hourly data for 1973 and 1974 for each monitor not previously submitted to EPA. Also, daily and yearly averages for 1973 and 1974 for each monitor.

6. For non-continuous sampling, 24 hour data for 1973 and 1974 for each monitor not previously submitted to EPA. Also, yearly averages for 1973 asnd 1974 for each monitor.

7. Type and frequency of monitoring calibration.

8. Type and frequency of laboratory analysis quality assurances.

9. Sampling height of probe for each monitor (above mean sea level).

10. If analog data acquisition is used, supply copy of strip chart for the second week of July, 1974, from each monitor.

11. Reasons for missing data.

D) Meteorological Data (for data collected on-site)

1. Method of collection of hourly wind direction and wind speed and vertical temperature profiles for 1973 and 1974 with description of seasons used.

Attachment 1 (cont.)

2. Hourly wind speed and wind direction data and hourly vertical temperature difference data for 1973 and 1974.

3. Sampling height (above mean seal level) of all probes for above measured parameters.

4. Station location(s) by UTH coordinates.

5. Any wind-stability rose data available for 1973 and 1974.

E) Stack Sampling Data for Sulfur Dioxide

1. Method used to determine sulfur dioxide content of flue gas stream.

2. Results of any tests (emission rates-pounds of sulfur dioxide per hour) for 1973 and 1974. Lacking results for 1973 and 1974, results of most recent test data.

Attachment 2

Data Required for Industrial Processes which Emit Sulfur Dioxide

A) Operating Characteristics

1. Identification and description of the process or processes operating in 1973 and 1974, which have capcity to emit sulfur dioxides.

2. Identify and locate (using Universal Transverse Mercator Coordinates-UTM) each stack that is associated with a process or processes.

3. Specify the physical characteristics of each stack including:

   A. Stack height above ground.
   B. Stack height above any attached building or structure.
   C. Stack diameter.
   D. Stack gas exit temperature.
   E. Stack gas exit velocity.

4. A sketch of the plant layout with the locations (relative to stacks) of all buildings surrounding the stacks, and showing stack spacing and locations and include approximate building height.

5. The maximum designed and normal production capacity, expressed in lb./hr. of each of the processes thast are identified as operating in 1973 and 1974.

B) Fuel Analysis for Use in Determining Sulfur Dioxide Emissions

If the following data is not readily available, please submit the type of fuel used, the name and address of the supplier and specify a person to cntact who will be able to answer these questions on an as-supplied basis. This analysis for sulfur content should include any fuel that is part of the process or processes identified in Section A of this Attachment. (example: fuel used in a heat treat furnace, fuel used in a rotary dryer, etc.)

1. Average monthly sulfur content of fuel for 1973 and 1974.

Attachment 2 (cont.)

2. Method used to determine the sulfur content of fuel.

3. Range of all sulfur content test results for 1973 and 1974.

4. Standard deviation of sulfur content for 1973 and 1974.

C) Air Monitoring Data for All Monitors Near the Plant for Sulfur Dioxide

1. Location of each monitor operated in 1973 and/or 1974 (Universal Transverse Mercator Coordinates-UTM).

2. Sample collection method (i.e. bubbler or continuous) for each monitor.

3. Sampling schedules for each monitor.

4. Sample analysis method (West Gaeke colorimetric, coulometric, etc.) for each monitor.

5. For continous sampling, hourly data for 1973 and 1974 for each monitor not previously submitted to EPA. Also, daily and yearly averages for 1973 and 1974 for each monitor.

6. For non-continous sampling, 24 hour data for 1973 and 1974 for each monitor not previously submitted to EPA. Also, yearly averages for 1973 and 1974 for each monitor.

7. Type and frequency of monitoring calibration.

8. Type and frequency of laboratory analysis quality assurance.

9. Sampling height of probe for each monitor (above mean seal level).

10. If analog data acquisition is used, supply copy of strip chart for the second week of July, 1974, from each monitor.

11. Reasons for missing data.

Attachment 2 (cont.)

D) Meteorological Data (for data collected on-site)

1. Method of collection of hourly wind direction and wind speed and vertical temperature profiles for 1973 and 1974 with descriptin of sensors used.
2. Hourly wind speed and wind direction data and hourly vertical temperature difference data for 1973 and 1974.
3. Sampling height (above mean sea level) of all probes for above measured parameters.
4. Station location(s) by UTM coordinates.
5. Any wind-stability rose data available for 1973 and 1974.

E) Stack Sampling Data for Sulfur Dioxide

1. Method used to determine sulfur dioxide content of flue gas stream.
2. Results of any tests (emission rates-pounds of sulfur dioxide per hour) for 1973 and 1974. Lacking results for 1973 and 1974, results of most recent test data.

B. Ambient Air Quality Data Base

1. Air Monitoring Network Requirements

Each State Implementation Plan (SIP) contains the State's commitments to provide for an ambient air quality surveillance system specifying (1) the basis for the design of the surveillance system, (i.e., selection of samplers, and sampling sites, (2) the locations of the samplers by Universal Transverse Mercator (UTM) grid coordinates or the equivalent, (3) the sampling schedules, (4) the methods of sampling and anaylsis, and (5) the method of data handling and analysis procedures.(1)(2)

Most States, including Ohio, have already established an air quality monitoring network for sulfur oxides, particulates, carbon monoxide, oxidants and nitrogen oxides to fulfill the Federal minimum network requirements. Table II.B.1 represents a summary of those requirements in Ohio by Air Quality Control Regions (AQCR).

Air quality monitoring within any AQCR should provide information to be used as a basis for the following purposes:

(1) Judging compliance with and/or progress made toward meeting the National Ambient Air Quality Standards (NAAQS).

(2) Activating emergency control procedures intended to prevent air pollution episodes.

(3) Determining pollution patterns and trends throughout a region.

TABLE II.B.1. Summary of Air Monitoring Network Requirements For Ohio

Air Quality Control Region	TSP Sites SIP*	TSP Sites MFR**	SO_2 Bubbler Sites SIP	SO_2 Bubbler Sites MFR	SO_2 Continuous Sites SIP	SO_2 Continuous Sites MFR	CO Sites SIP	CO Sites MFR	Oxidant Sites SIP	Oxidant Sites MFR
Cincinnati(079)	41	10	16	2	7	1	9	0	2	9
Huntington-Portsmouth-Ironton(103)	19	3	3	0	2	0	0	0	0	0
Toledo(124)	16	7	5	5	7	2	2	0	2	2
Dayton(173)	26	10	16	3	3	1	3	0	3	4
Cleveland(174)	82	16	22	11	6	6	6	0	6	6
Mansfield-Marion(175)	3	3	3	3	1	1	0	0	0	0
Columbus(176)	11	10	6	1	3	0	3	0	4	3
Northwest Ohio(177)	4	3	5	5	2	2	0	0	0	0
Northwest Penn-Youngstown(178)	15	4	6	1	2	0	0	0	0	0
Parkersburg-Marietta(179)	5	3	1	1	4	0	0	0	0	0
Sandusky(180)	6	1	2	1	0	0	0	0	0	0
Steubenville-Wierton-Wheeling(181)	22	4	5	3	1	1	0	0	0	0
Wilmington-Chillicothe-Logan(182)	4	1	1	1	1	0	0	0	0	0
Zanesville-Cambridge(183)	5	3	1	3	4	1	0	0	0	0

* = STATE IMPLEMENTATION PROPOSED
** = MINIMUM FEDERAL REQUIRED

(4) Developing a data base for the assessment of health and welfare effects, for land use and transportation planning, for the study of pollutant interactions, for the evaluation of the effectiveness of abatement strategies and enforcement control regulations, and for validation of mathematical models.

2. Sulfur Dioxide Monitoring

Ambient SO_2 air quality data provides an indication of the SO_2 air quality levels in the vicinity of specific air monitoring stations. Guidelines established by U.S. EPA include determining the number and location of sampling sites, selecting appropriate instrumentation, determining frequency of sampling, and following established instrument siting criteria.(3-7) Most monitoring site locations are classified as (1) either population oriented (urban or suburban), (2) source oriented (industrial points), or (3) background oriented (rural). Generally the monitoring conducted in metropolitan areas is population oriented although data collected in the vicinity of large sources may be considered as source specific. Non-urban sites are generally considered as background oriented.

3. Sulfur Dioxide Methodology

Methods for measuring pollutants fall into one of three categories: (1) approved, (2) unacceptable, and (3) unapproved (neither approved nor unacceptable). Unapproved methods may become approved only by demonstrating equivalence to the federal reference method described in Appendices to 40 CFR Part 50 (36 FR 8186, April 30, 1971). Those methods designated unacceptable are not equivalent to the reference method and are considered to be obsolete.

Acceptable: Reference - Pararosaniline Method "91"
(24 hr. Bubbler)

Sulfur dioxide is absorbed from air in a solution of potassium tetrachloromercurate (TCM) a dichlorosulfitomercurate complex, which resists oxidation by the oxygen in the air is formed. The complex is reacted with pararosaniline and formaldehyde to form intensely colored pararosaniline methyl sulfonic acid. The absorbance of the solution is measured spectrophotometrically.

Sampling period: Up to 24 hours.

Range: 25 ug/m^3 to 1050 ug/m^3

Sensitivity: Lower limit of 25 ug/m^3 SO_2 in air sample of 30 liters.

Precision: Relative standard deviation at 95% confidence level is 4.6%

Collection efficiency: 98% above 25 ug/m^3

Unapproved: Instrumental - West Gaeke - Colorimetric Method 11

A continuous analyzing system is set up such that ambient air flows through a glass beaded absorption column concurrently with 0.02m sodium tetrachloromercurate. Dichlorosulfitomercurate ion is formed, reacted with acid-bleached pararosaniline and formaldehyde to produce a red-purple pararosaniline methylsulfonic acid which is quantitatively measured colorimetrically.

Air flow rate and reagent flow rate must be calibrated and maintained accurately.

Unapproved: Instrumental - Conductimetric

Sulfur dioxide is absorbed in acidic H_2O_2 which oxidizes the SO_2 to H_2SO_4. The resulting change in conductivity can be measured and related to input SO_2 concentration by dynamic calibration; however, specificity is poor because any materials that alter the conductivity of the reagent are potential interfering agents.

Unapproved: Instrumental - Coulometric

The air to be measured is passed through a cell containing a neutral buffered iodide or bromide electrolyte where an electrical current or potential maintains a constant concentration of free I_2 or Br_2. If the input flow rate is constant, the SO_2 concentration can be related to the electric signal by dynamic calibration with known SO_2 concentration standards.

Unacceptable: U.S. EPA guidelines rank the conductimetric bubbler method 93, as unacceptable. There are no sites recorded in Ohio utilizing this method.

4. Agency Surveys

The U.S. EPA has performed periodic evaluations of the ambient air monitoring operations of funded agencies in Ohio since 1973. The reviews were conducted in accordance with the guidelines specified in the November 25, 1971 Federal Register, Volume 36, Number 228, "National Primary and Secondary Ambient Air Quality Standards."

To attain the objective of establishing a valid air quality data base, U.S. EPA reviewed these agencies for approved air monitoring methods and standardized analysis, calibration, maintenance, and data reporting procedures.

In the majority of agencies, methodologies of sampling analysis were approved by U.S. EPA with only variations in laboratory techniques noted.

5. Quality Assurance Activities

In March, 1974 Ohio EPA initiated a quality assurance program to determine the accuracy and precision of sulfur dioxide bubbler analysis in Ohio. Participating in these studies were the agencies Akron, Canton, Cincinnati, Cleveland, Lake County, Lorain, Mohoning-Trumbull (Youngstown), North Ohio Valley Air Authority (Steubenville), Regional Air Pollution Control (Dayton Region) and Toledo. Thus only data collected subsequent to the initiation of these tests in 1974 has been assessed with respect to laboratory validity. However, these results have shown no agency to have consistently biased analyses.

The U.S. EPA conducted SO_2 interlaboratory survey in December of 1974. Those participants from Ohio were Akron, Cincinnati, Dayton, Toledo, Youngstown, and Ohio EPA (Department of Health Laboratory). Only Cincinnati and Youngstown showed at least one sample out of acceptable limits. Again, it must be emphasized that validity of data before these tests cannot be assessed on the basis of these interlaboratory surveys.

6. Outline of Air Quality Summaries

Appendix G provides air quality summaries by Air Quality Control Region (AQCR) for 1973 and 1974. Included in each AQCR section is a site monitoring summary of the area, (county and SAROAD code), agency or agencies responsible for air monitoring, and a site by site listing of air quality data summaries. These data summaries include address of the site, equipment type used (gas bubbler or continuous monitor) and years of data submitted and available in the National Aerometric Data Bank as of January, 1976. For those monitoring sites employing acceptable methods of sampling and analysis, the UTM coordinated and summary statistics are listed. Those sites for which data is present during all four quarters of each year are summarized with an annual mean. Others having insufficient sampling are listed as SCNM (Sampling Criteria Not Met).

References for B. Ambient Air Quality Data Base

1. Federal Register Volume 36, Number 84, April 30, 1971.
2. Federal Register Volume 38, Number 178, September 14, 1973.
3. Guidance for Air Quality Monitoring Network Design and Instrument Siting. (OAQPS number 1.2-012)
4. Designation of Unacceptable Analytical Methods of Measurement for Criteria Pollutants. (OAQPS number 1.2-018)
5. Procedures for Flow and Auditing of Air Quality Data. (OAQPS number 1.2-013)
6. Guidelines for the Evaluation of Air Quality Data. (OAQPS number 1.2-015)
7. Guidelines for the Evaluation of Air Quality Trends. (OAQPS number 1.2-014)

C. Meteorological Data Base

The State of Ohio and its bordering states have ten (10) primary National Weather Service (NWS) surface observation stations which are important to any modeling work. These NWS sites include Akron, Cincinnati (Covington, Kentucky), Cleveland, Columbus, Dayton, Toledo, and Youngstown in Ohio; Erie and Pittsburgh in Pennsylvania; and Huntington in West Virginia. Radiosonde stations of the NWS which have bearing on the diffusion modeling in Ohio include: Dayton, Ohio; Flint, Michigan; Buffalo, New York; Pittsburgh, Pennsylvania; and Huntington, West Virginia.

A total of fourteen (14) Federal Air Quality Control Regions (AQCR's) are located in Ohio.(1) Every AQCR in Ohio does not contain a primary NWS surface observation station; therefore, combination files of surface and upper air meteorological data have been created which will best reflect the representative meteorological conditions for each power plant modeled. Some of the combination files used surface and/or upper air data from sites which were not closest to the power plant. However, this selection was based upon terrain features as well as the proximity of the NWS site. A summary of the surface and upper air meteorological sites with a listing of the Ohio counties of which they are representative is given in Table II.C.1. Figure 1 shows a map of Ohio, and each of its 88 counties is identified.

TABLE II.C.1 Surface and Upper Air Meteorological Stations With Their Representative State of Ohio Counties

Surface/Upper Air Meteorological Sites	Representative Counties
1. Akron/Pittsburgh	Ashland
	Medina
	Portage
	Richland
	Stark
	Summit
	Tuscarawas
	Wayne
2. Cincinnati/Dayton	Adams
	Brown
	Butler
	Clermont
	Clinton
	Hamilton
	Highland
	Warren
3. Cleveland/Erie	Cuyahoga
	Erie
	Geauga
	Huron
	Lake
	Lorain

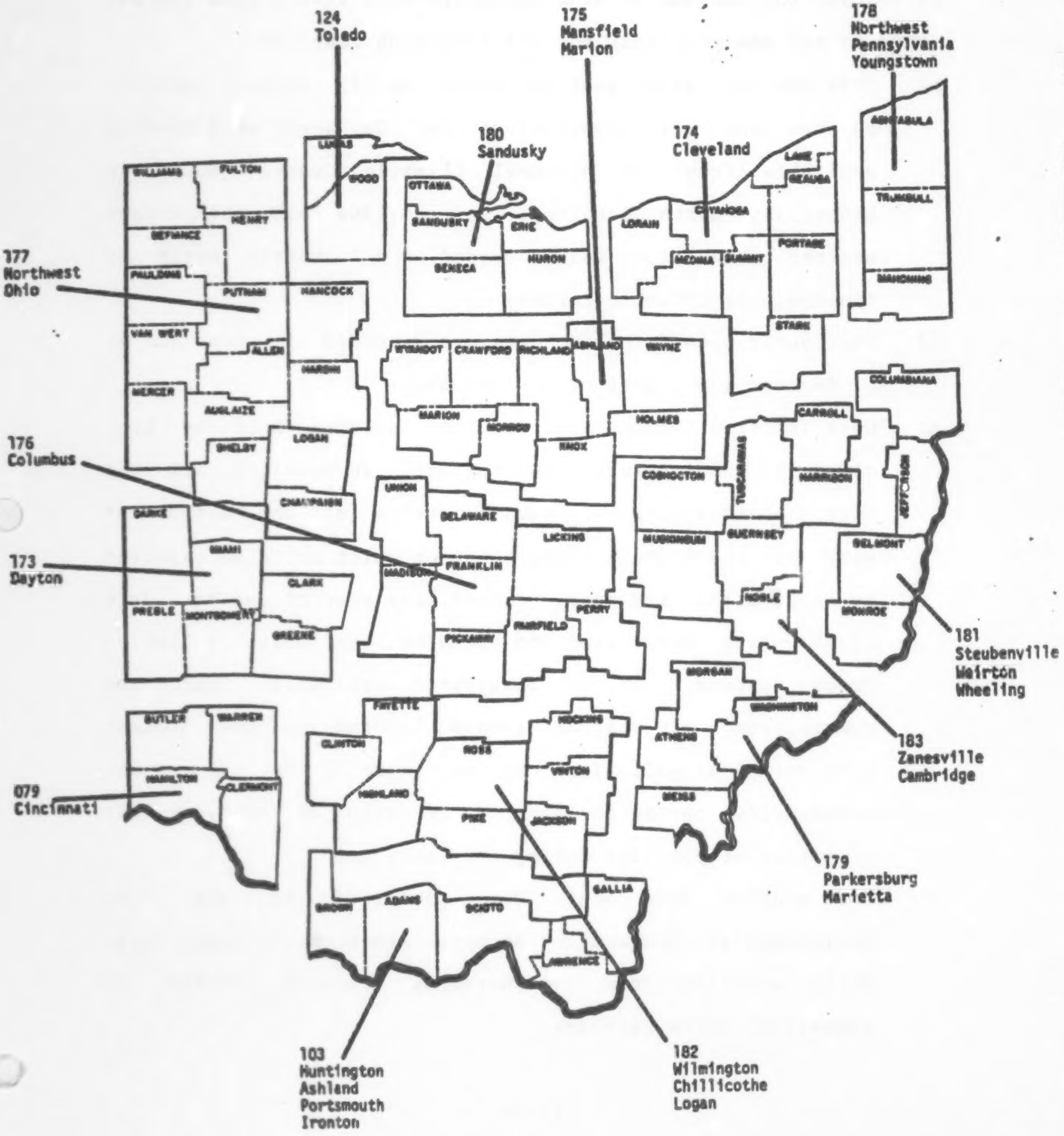
Table II.C.1 continued.

4. Columbus/Dayton	Crawford
	Coshocton
	Delaware
	Fairfield
	Fayette
	Franklin
	Hancock
	Hardin
	Hocking
	Knox
	Licking
	Madison
	Marion
	Morrow
	Muskingum
	Perry
	Pickaway
	Ross
	Union
	Wyandot
5. Dayton/Dayton	Allen
	Auglaize
	Champaign
	Clark
	Darke
	Greene
	Logan
	Mercer
	Miami
	Montgomery
	Paulding
	Preble
	Putnam
	Shelby
	Van Wert

Table II.C.1 continued.

6.	Erie/Buffalo	Ashtabula
7.	Huntington/Huntington	Athens Gallia Jackson Lawrence Meigs Morgan Pike Scioto Vinton Washington Also Consider: Adams Brown Clinton Highland
8.	Pittsburgh/Pittsburgh	Belmont Carroll Columbiana Guernsey Harrison Jefferson Monroe Noble
9.	Toledo/Flint	Defiance Fulton Henry Lucas Ottawa Sandusky Seneca Williams Wood
10.	Youngstown/Pittsburgh	Mahoning Trumbull

Figure 1


124
Toledo
175
Mansfield
Marion
178
Northwest
Pennsylvania
Youngstown
180
Sandusky
174
Cleveland
177
Northwest
Ohio
176
Columbus
173
Dayton
079
Cincinnati
181
Steubenville
Weirton
Wheeling
183
Zanesville
Cambridge
179
Parkersburg
Marietta
103
Huntington
Ashland
Portsmouth
Ironton
182
Wilmington
Chillicothe
Logan
WILLIAMS
FULTON
LUCAS
WOOD
OTTAWA
SANDUSKY
ERIE
SENECA
HURON
LORAIN
CUYAHOGA
LAKE
GEAUGA
ASHTABULA
TRUMBULL
MEDINA
SUMMIT
PORTAGE
MAHONING
STARK
DEFIANCE
HENRY
PAULDING
PUTNAM
HANCOCK
VAN WERT
ALLEN
HARDIN
MERCER
AUGLAIZE
SHELBY
LOGAN
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
WAYNE
MARION
MORROW
KNOX
HOLMES
COLUMBIANA
CARROLL
TUSCARAWAS
HARRISON
JEFFERSON
COSHOCTON
UNION
DELAWARE
LICKING
MUSKINGUM
GUERNSEY
BELMONT
CHAMPAIGN
DARKE
MIAMI
CLARK
MADISON
FRANKLIN
PREBLE
MONTGOMERY
GREENE
FAIRFIELD
PERRY
NOBLE
MONROE
PICKAWAY
MORGAN
WASHINGTON
FAYETTE
BUTLER
WARREN
HOCKING
CLINTON
ROSS
ATHENS
HAMILTON
CLERMONT
VINTON
HIGHLAND
MEIGS
PIKE
JACKSON
GALLIA
BROWN
ADAMS
SCIOTO
LAWRENCE

The meteorological data for the year 1964 were used in estimating the maximum 24 hour concentrations from single sources (MAXT 24 and RAM programs) for the following reasons:

a) 1964 was the latest year for which hourly surface weather observations (24 observations per day week) were readily available from the National Climatic Center (NCC) in Asheville, North Carolina. After 1964 all the surface weather observations were recorded on a 3 hourly basis by the National Climatic Center;

b) The hourly wind direction data was recorded in tens (10's) of degrees (36 points of the compass);

c) Data input to the MAXT 24 program includes hour by hour standard NWS surface observations. In modeling, all 1964 hourly observations were used to arrive at the output of MAXT 24, the highest concentrations which could be expected to occur within the year. Indeed, any year of weather data could have been used to predict the worst pollution concentrations. It is considered realistic that the combination of weather events leading to the highest predictions of pollution can be expected to occur, not necessarily during the same day or season of each year, but certainly at sometime during any year; and

d) The weather data sets were obtained by the U.S. Environmental Protection Agency, Research Triangle Park, North Carolina from the National Climatic Center in Asheville, North Carolina.

Meteorological Data (CDM)

The Climatological Dispersion Model (CDM) can be used to obtain estimates of long-term sulfur dioxide (SO) concentrations from point and area sources in urban areas of Ohio. (A description of the model is contained in Section IX.) As input for the model, information on the joint frequency function q (k, l, m) is needed. This function gives the joint frequency of occurrence of a wind direction sector, k; a wind speed class, l; and stability category index, m. A total of 576 entries are possible in this joint frequency function resulting from 16 different wind directions, 6 different wind speed classes, and 6 stability classes. The Day-Night version of the National Climatic Center (NCC) STAR program provides the proper form of the joint frequency distribution for input into CDM. Meteorological data for 1973 and 1974 have been used for calibration of the model in Toledo, Akron, and Cleveland. The results and procedures used in the calibration are contained in Section IV and VIII of this document. A span of five years was covered by the meteorological data used with CDM for strategy development purposes. The years covered along with location of the meteorological station for Cleveland, Toledo, and Akron are listed in Table II.C.2.

TABLE II.C.2. CDM Meteorological Data

Meteorological data in the form of stability wind rose summaries were obtained from NOAA - NCC, Asheville, North Carolina, for the airport located neartest each metropolitan area. Data for the years 1973, 1074 and for a five year period, as follows, were used:

	TOLEDO		AKRON		CLEVELAND	
	Calibration	Strategy	Calibration	Strategy	Calibration	Strategy
Airport Name	Toledo Express	Toledo Express	Akron - Canton	Akron - Canton	Cleveland Hopkins Apt	Cleveland Hopkins Apt
Station Number	94830	94830	14895	14895	14820	14820
Location	14 mi. W Toledo		12 mi. SSE Akron		Brook Park/Fairview Park 8 miles S.W. Cleveland	
Latitude	41°36′N	41°36′N	40°55′N	40°55′N	41°24′N	41°24′N
Longitude	83°48′W	83°48′W	81°26′W	81°26′W	BLK	BLK
UTM-X	267.3	267.3	463.5	463.5	81°51′W	81°51′W
UTM-Y	4608.8	4608.8	4529.4	4529.4	BLK	BLK
UTM Zone	16	16	17	17	17	17
Wind Rose Period	1 YR ANNUAL	5 YR ANNUAL	1 YR ANNUAL	5 YR ANNUAL	1 YR ANNUAL	5 YR ANNUAL
Year of Record	1973	1964-68	1973	1960-64	1974	1969-73

References for C. Meteorological Data Base

1. "Federal Air Quality Control Regions," U.S. Environmental Protection Agency, Office of Air Programs, Rockville, Maryland, January, 1972.

D. AIR QUALITY BACKGROUND DETERMINATION

1. Methodology Used

The MAXT24 dispersion model was used to calculate the highest 24-hour ground level SO_2 concentrations using emissions data from rual power plants and other large SO_2 sources in Ohio. The Source Receptor Analysis Branch (SRAB) of the Monitoring and Data Analysis Division (MDAD) of OAQPS applied this modeling technique (MAXT24) to 20 major rural SO_2 sources. SRAB examined the 20 highest 24-hour ground level SO_2 concentrations at each source to determine if any pattern existed between the maximum daily SO_2 levels and certain meteorological parameters. The parameters examined at each of the major sources are shown in Table 1 which gives a listing of:

1) The source;

2) Source location by county:

3) Representative surface weather and upper air weather to be used in the modeling;

4) Location of the source by UTM coordinates;

5) Wind direction;

6) Wind speed (in meters per second);

7) Stability classification and its duration;

8) Mixing heights, (in meters) both morning and afternoon; and

9) Season of occurrences.

MAXT24 was run 20 times for each of the large rural SO_2 sources listed in Table II-D-1 using 1964 weather data. The purpose of these MAXT 24 runs was to determine if any

TABLE II.D.1

Plant	County	Sfc Wx/Upper Air Wx	UTM Coordinates		Wind Direction	Wind Speed	Stability & Duration	Mixing Heights	Julian Days
			Easting(x)	Northing(y)					
PHILO	Muskigum	Columbus/Dayton	422.60	4415.88	Strong, steady W to NW Winds for 12-24 hrs.	4-12 mps	Neutral(D) Stability (For 12 to 24 hours)	Morning: 500m Afternoon: 2000m	225, 283, 326, & 359 Summer, Autumn, Winter
PICKWAY	Pickway	Columbus/Dayton	327.88	4406.540	Strong, steady W Winds for 12 to 22 hrs.	5-13 mps	Neutral(D) Stability (For 12-22 hrs.)	Morning: 1000m Afternoon: 1800m	Winter, Spring
CONESVILLE	Coshocton	Columbus/Dayton	425.05	4448.38	Moderate to Strong, steady SE winds-For 11 to 18 Hrs. Per Day.	4-8 mps	Neutral(D) Stability (For 11 to 18 hours Per Day)	Morning: 400m Afternoon: 600m	Winter, Spring

Plant	County	Sfc Wx/Upper Air Wx	UTM Coordinates Easting(x)	 Northing(y)	Wind Direction	Wind Speed
MEAD PAPER	Ross	Columbus/Dayton	330.00	4354.43	Light to Moderate-Northerly Winds for 7 to 17 hours.	1-6 mps
	Stability & Duration Unstable(A-C) Stability (For 7 to 17 hours)	Mixing Heights Morning: 1100m Afternoon: 2400m			Julian Days Summer	
TIDD	Jefferson	Pittsburgh/ Pittsburgh	529.9	4455.55	West Wind for 11-18 hours of the day.	4-14 mps
	Stability & Duration Neutral(D) Stability (For 11 to 18 hours)	Mixing Heights Morning: 700m Afternoon: 1800m		Julian Days 010, 004, 326, 086, 039, 100, 087, & 026 Winter Through Spring		
CARDINAL	Jefferson	Pittsburgh/ Pittsburgh	530.32	4456.00	South Wind for 8 to 9 hrs. of the day.	4-7 mps
	Stability & Duration Unstable to Neutral Stability(Class 1-4) (For 8 or 9 hrs. of the day)	Mixing Heights Morning: 1900m Afternoon: 2100m		Julian Days 126, 127 Spring		
POSTON	Athens	Huntington/ Huntington	398.4	4358.6	Strong, steady Westerly Winds for 8-18 hours.	3-9 mps
	Stability & Duration Slightly Unstable(C) Neutral(D) stability (For 8 to 18 hours of the day)	Mixing Heights Morning: 500m Afternoon: 2000m			Julian Days Mostly Winter & Spring	

Plant	County	Sfc Wx/Upper Air Wx	UTM Coordinates Easting(x)	 Northing(y)	Wind Direction	Wind Speed
MUSKINGUM RIVER	Morgan	Huntington/ Huntington	441.6	4382.3	Southwest Winds for 2 hours	1-3 mps
	Stability & Duration Unstable (A) Stability	Mixing Heights Morning: 1300m Afternoon: 2100m		Julian Days 174, 208 Summer		
STUART	Adams	Cincinnati/Dayton	263.9	4280.2	Southwesterly Winds for 2-11 Hours.	1-5 mps
	Stability & Duration Unstable Stability (A-C) Class for 2 to 11 hours	Mixing Heights Morning: 1300m Afternoon: 2100m		Julian Days 126, 184, 197, 207 Spring, Summer		
GAVIN	Gallia	Huntington/ Huntington	403.03	4309.53	Northeast Winds for 1-3 hours	1-3 mps
	Stability & Duration Unstable Stability (A-B)(For 1-3 hrs.)	Mixing Heights Morning: 2100m Afternoon: 2300m		Julian Days Summer		
KYGER CREEK	Gallia	Huntington/ Huntington	402.1	4307.7	Northeast Winds for 2-3 hours	1-3 mps
	Stability & Duration Unstable Stability (A-B)(For 2-3 hrs.)	Mixing Heights Morning: 1500m Afternoon: 2300m			Julian Days 146, 204 Spring, Summer	
PHILIP SPORN	NO DATA AVAILABLE ON THIS PLANT.					

Plant	County	Sfc Wx/Upper Air Wx	UTM Coordinates Easting(x)	UTM Coordinates Northing(y)	Wind Direction	Wind Speed
ASTUBULA	Ashtabula	Erie/Buffalo	519.1	4639.4	Strong, Persistent Northwesterly Winds for 12-24 hrs.	6-11 mps
	Stability & Duration Neutral Stability (D)(For 12-24 hours)	Mixing Heights Morning: 500m Afternoon: 1400m		Julian Days August through December Summer, Autumn, Winter		
RMI METAL	Ashtabula	Erie/Buffalo	518.6	4636.1	Southeast Winds for 20-24 hrs.	6-15 mps
	Stability & Duration Neutral (D) Stability Class	Mixing Heights Morning: 700m Afternoon: 1100m		Julian Days 118, 264, 265, 097 Spring, Autumn		
RMI SODIUM	Ashtabula	Erie/Buffalo	519.1	4638.5	Southeast Winds for 20-24 hrs.	6-14 mps
	Stability & Duration Neutral Stability Class (D)	Mixing Heights Morning: 800m Afternoon: 1500m		Julian Days 097, 118, 120, 264, 265 Spring, Summer		
NEW JERSEY ZINC	Ashtabula	Erie/Buffalo	519.0	4637.5	Southeast Winds for 20-24 hours	6-15 mps
	Stability & Duration Neutral (D) Stability 20 to 24 hours	Mixing Heights Morning: 700m Afternoon: 1100m		Julian Days 097, 118, 264, 265 Spring, Autumn		

Plant	County	Sfc Wx/Upper Air Wx	UTM Coordinates Easting(x)	UTM Coordinates Northing(y)	Wind Direction	Wind Speed
GENERAL TIRE	Ashtabula	Erie/Buffalo	519.4	4638.0	Southeast Winds for 20 to 24 hrs.	6-15 mps
	Stability & Duration	Mixing Heights			Julian Days	
	Neutral (D) Stability for 20 to 24 hours	Morning: 700m Afternoon: 2100m			097, 118, 120, 264, 265 Spring, Autumn	
MAD RIVER	Clark	Dayton/Dayton	256.2	4423.1	Strong, steady Westerly Winds for 15-24 hrs.	5-11 mps
	Stability & Duration	Mixing Heights			Julian Days	
	Neutral (D) Stability for 15 to 24 hours	Morning: 1000m Afternoon: 1900m			November through April Fall, Winter	
MIAMI FORT	Hamilton	Cincinnati/Dayton	689.9	4331.5	Strong, steady Southwest winds for 15-24 hrs.	3-12 mps
	Stability & Duration	Mixing Heights			Julian Days	
	Neutral (D) Stability for 15 to 20 hours	Morning: 400m Afternoon: 2100m			Fall, Winter, Spring	
BECKJORD	Clermont	Cincinnati/Dayton	733.9	4319.3	Strong, steady Southwest Winds for 10-20 hrs.	3-16 mps
	Stability & Duration	Mixing Heights			Julian Days	
	Neutral (D) Stability for 10 to 20 hours	Morning: 700m Afternoon: 2100m			Autumn, Winter, Spring	

relationship existed between season/seasons of the year, wind direction, wind speed, and the maximum ground level SO_2 concentrations. For those days in 1974 which met the 1964 criteria presented in Table II-D-1, the second maximum background SO_2 concentration was determined and used as the background value in the SO_2 modeling.

2. Summary of Findings

County wide background levels as determined by the Table II-D-1 criteria are presented in Table 2 and Figure 2.

TABLE 2. Air Quality Background Concentration by County

COUNTY	BACKGROUND SO_2 CONCENTRATIONS (ug/m^3)	METHOD OF DETERMINATION
Adams	72	GCA Report on Stuart Power Plant; EPA-450/ 3-76-002
Allen	35	Interpolation
Ashland	25	Interpolation
Ashtabula	50	Interpolation
Athens	31	1973 hourly wind velocities & SO concentrations for Poston Power Plant
Auglaize	45	Interpolation
Belmont	80	Ohio EPA Air Quality Data
Brown	50	Interpolation
Butler	52	Ohio EPA Air Quality Data
Carroll	65	Interpolation
Champaign	55	Interpolation
Clark	64	Ohio EPA Air Quality Data
Clermont	50	Ohio EPA Air Quality Data
Clinton	35	Interpolation
Columbiana	64	Ohio EPA Air Quality Data
Coschocton	63	1973 hourly wind velocity & SO_2 concentrations for Conesville Power Plant

TABLE 2. Air Quality Background Concentration by County (Con't)

COUNTY	BACKGROUND SO_2 CONCENTRATIONS (ug/m³)	METHOD OF DETERMINATION
Crawford	20	Interpolation
Cuyahoga	-	Urban Area; CDM used
Darke	106	Ohio EPA Air Quality Data
Defiance	20	Interpolation
Delaware	50	Interpolation
Erie	15	Interpolation
Fairfield	65	Interpolation
Fayette	55	Interpolation
Franklin	75	Interpolation
Fulton	10	Interpolation
Gallia	40	Interpolation
Geauga	127	Ohio EPA Air Quality Data
Greene	59	Ohio EPA Air Quality Data
Guernsey	80	Interpolation
Hamilton	53	Ohio EPA Air Quality Data
Hancock	25	Interpolation
Hardin	35	Interpolation
Harrison	80	Interpolation
Henry	15	Interpolation
Highland	40	Interpolation

TABLE 2. Air Quality Background Concentration by County (Con't)

COUNTY	BACKGROUND SO_2 CONCENTRATIONS (ug/m^3)	METHOD OF DETERMINATION
Hocking	40	Interpolation
Holmes	40	Interpolation
Huron	20	Interpolation
Jackson	25	Interpolation
Jefferson	145	Ohio EPA Air Quality Data
Knox	50	Interpolation
Lake	25	Ohio EPA Air Quality Data
Lawrence	47	Ohio EPA Air Quality Data
Licking	65	Interpolation
Logan	45	Interpolation
Lorain	18	Ohio EPA Air Quality Data
Lucas	-	Urban Area; CDM used
Madison	65	Interpolation
Mahoning	141	Ohio EPA Air Quality Data
Marion	35	Interpolation
Medina	21	Ohio EPA Air Quality Data
Meigs	35	Interpolation
Mercer	50	Interpolation
Miami	66	Ohio EPA Air Quality

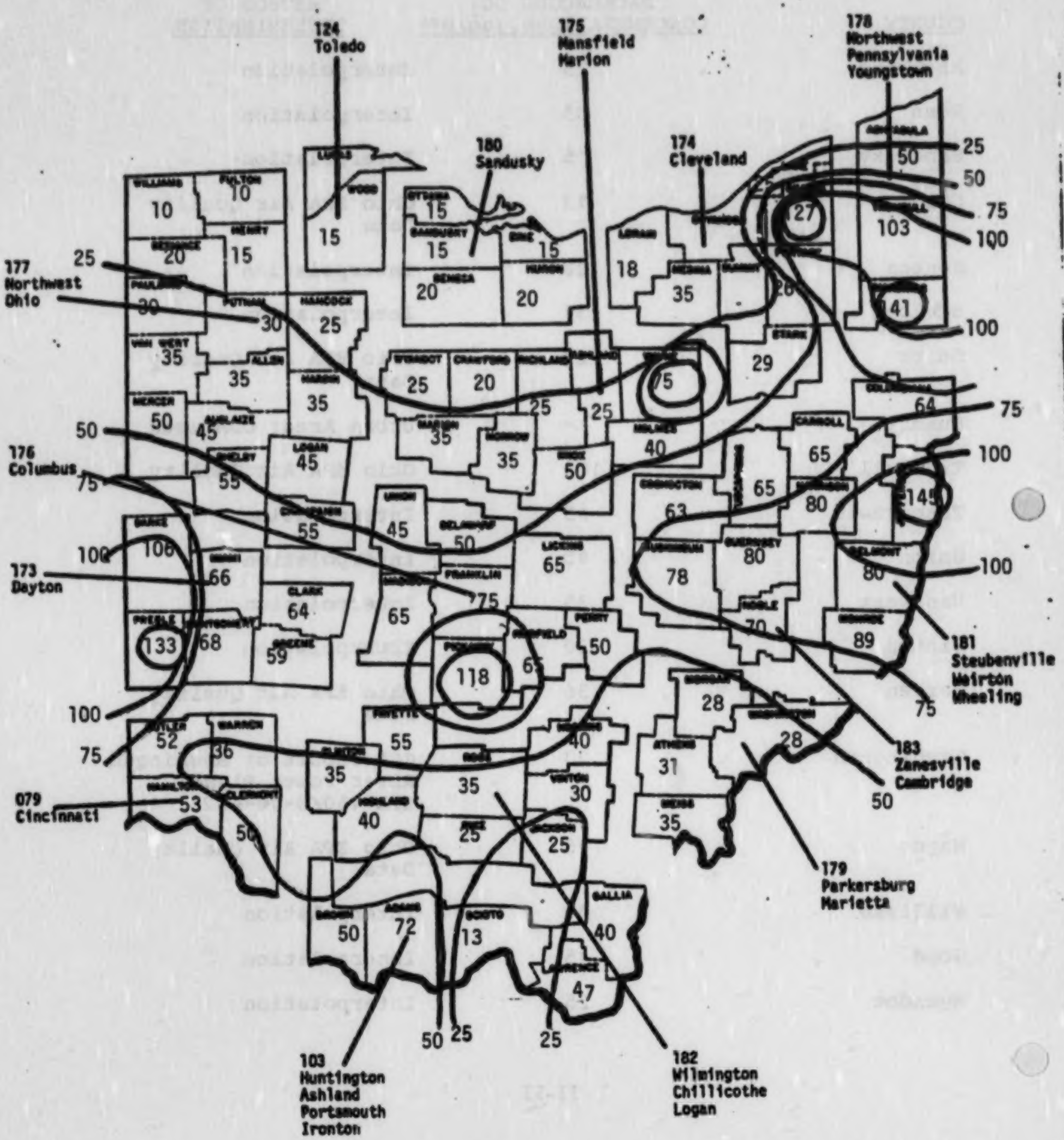
TABLE 2. Air Quality Background Concentration by County (Con't)

COUNTY	BACKGROUND SO_2 CONCENTRATIONS (ug/m³)	METHOD OF DETERMINATION
		Data
Monroe	89	Ohio EPA Air Quality Data
Montgomery	68	Ohio EPA Air Quality Data
Morgan	28	GCA report of Muskingum River Plant; EPA-450/3-76-002
Morrow	35	Interpolation
Muskingum	78	GCA report on Philo Plant; EPA-450/3-76-002
Noble	70	Interpolation
Ottawa	15	Interpolation
Paulding	30	Interpolation
Perry	50	Interpolation
Pickaway	118	1973 hourly wind velocities & SO concentrations at Pickaway Power Plant of Columbus & Southern Power Co.
Pike	25	Interpolation
Portage	26	Ohio EPA Air Quality Data
Preble	133	Ohio EPA Air Quality Data
Putnam	30	Interpolation

TABLE 2. Air Quality Background Concentration by County (Con't)

COUNTY	BACKGROUND SO_2 CONCENTRATIONS (ug/m^3)	METHOD OF DETERMINATION
Richland	25	Interpolation
Ross	35	Interpolation
Sandusky	15	Interpolation
Scioto	13	Ohio EPA Air Quality Data
Seneca	20	Interpolation
Shelby	55	Interpolation
Stark	29	Ohio EPA Air Quality Data
Summit	-	Urban Area; CDM used
Trumbull	103	Ohio EPA Air Quality
Tuscarawas	65	Interpolation
Union	45	Interpolation
Van Wert	35	Interpolation
Vinton	30	Interpolation
Warren	36	Ohio EPA Air Quality Data
Washington	28	GCA report of Muskingum River Power Plant; EPA-450/3-76-002
Wayne	75	Ohio EPA Air Quality Data
Williams	10	Interpolation
Wood	15	Interpolation
Wyandot	25	Interpolation

Figure 2. Ambient Sulfur Dioxide 24-Hour Background by County


124
Toledo
175
Mansfield
Marion
178
Northwest
Pennsylvania
Youngstown
180
Sandusky
174
Cleveland
177
Northwest
Ohio
176
Columbus
173
Dayton
079
Cincinnati
103
Huntington
Ashland
Portsmouth
Ironton
182
Wilmington
Chillicothe
Logan
179
Parkersburg
Marietta
183
Zanesville
Cambridge
181
Steubenville
Weirton
Wheeling
10
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47
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SECTION III

EMISSION LIMITATION STRUCTURE FOR REGULATED SOURCE CATEGORIES

SECTION III. EMISSION LIMITATION STRUCTURE FOR REGULATED SOURCE CATEGORIES

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Introduction

A. Fuel Combustion Sources III-1

B. Industrial Process Sources III-2

SECTION III. EMISSION LIMITATION STRUCTURE FOR REGULATED SOURCE CATEGORIES

INTRODUCTION

This section describes the units of the emission limitations selected for the various source categories regulated in the Ohio SO_2 plan. Table 3-1 summarizes these units. Also the procedure for determining application of the regulations is discussed.

A. Fuel Combustion Sources

The basic type of emission limitation for application to fossil fuel-fired steam generators is expressed in units of pounds of sulfur dioxide per million BTU of actual heat input. The allowable emission rate of sulfur dioxide in pounds per hour for a given stack is determined by aggregating the actual heat input per hour of all steam generating units connected to any stack and multiplying this times the allowable emission rate.

In urban areas a sliding scale regulation is sometimes used. This yields an allowable emission rate for a stack in units of lb. SO_2 /MBtu heat input determined by the total rated capacity of all fossil fuel-fired steam generating units connected to the stack in units of MBtu/hour. There is a fixed allowable emission rate for those facilities which have a total rated capacity greater than or equal to the upper sliding scale limit (units of MBTu/hour). There is also a fixed allowable emission rate for those facilities having a total rated capacity less than or equal to the lower sliding scale limit. In between this upper limit and lower limit, the allowable rate is determined by applying the exponential equation to obtain the applicable allowable emission rate. Compliance with these regulations will be determined by comparing the allowable emission rate, determined as described above with the actual emission rate determined by either stack tests or emission factor calculations based on the sulfur content and heating value characteristics of the fuel.

E. Industrial Process Sources

1. General - Industrial process source emission limitations have been classified into seven types for purposes of this rulemaking: (1) A general process - weight rate curve in counties where necessary giving allowable emissions in pounds of SO_2 per ton of process weight (2) A source-specific regulation in counties where necessary for sulfuric acid plants giving an allowable emission rate in pounds of SO_2 per ton of 100% acid produced. (3) A source-specific regulation for sulfur recovery plants giving an allowable emission rate in pounds of SO_2 per 1000 pounds of sulfur processed. (4) A fuel gas concentration limitation for coke oven gas expressed in grains of H_2S per 100 dry standard cubic foot of coke oven gas. (5) A fuel gas concentration limitation of oil refinery gas expressed in grains of H_2S per 100 dry standard cubic foot for oil refinery gas. (6) A source-specific regulation for catalytic cracking units expressed as pounds of SO_2 per 1000 pounds of charging stock or percent SO_2 removal efficiency as applicable. (7) A

source-specific regualtion for primary zinc smelters giving an allowable emission rate in pounds per hour.

Major industrial process contributors to SC_2 emissions include chemical plants (sulfuric acid), primary non-ferrous metal smelters, iron and steel mills (coke ovens), petroleum refineries including catalytic cracking units and sulfur recovery plants. For the purposes of this rulemaking, specific regulations are promulgated for six source categories under 3 major industrial groups. All other industrial sources were considered for emission limitation through the application of a general process-weight rate when necessary. The three major industrial groups and related source categories for which specific emissions limitations were examined included:

(1) The chemical industries group (i.e. sulfuric acid plant operations),

(2) The metals industries group (i.e. primary non-ferrous smelters and coke oven operations), and

(3) The petroleum refining and industrial fuel combustion group (i.e. petroleum refinery off-gas combustion, catalytic cracking units, and associated sulfur recovery plants).

2. Sulfuric Acid Plants - Sulfuric acid is produced by chemical companies and by operators of non-ferrous smelters.

Compliance with sulfuric acid plant regulations will be determined by comparing the actual emission rate in units of pounds SO_2/ton of 100% H_2SO_4 produced with the applicable allowable limit in units of pounds of SO_2/ton of 100% H_2SO_4 produced. The actual emission rate will be determined by dividing the emissions measured in pounds/hour by the amount of acid produced. Emission rate in pounds/hour will be determined by stack testing to obtain the volumetric flow rate of the effluent (Q) and the SO_2 concentration (C). Emission rate will be obtained by multiplying Q and C. The 100% acid produced will be determined by suitable flow meters during the testing period and it will be confirmed by a material balance over the production system. EPA method 1, 2, 3, and 6 should be used as testing procedures.

3. Sulfur Recovery Plants

The sulfur recovery plant can be a major source of SO_2 emissions. Sulfur dioxide is the main incineration product from the process and the emission is a function of the number of conversion stages employed, the process temperature and pressure, and the amounts of carbon compounds present in the pressurized boiler.

These plants are used at petroleum refineries and sour natural gas processing operations. In the sulfur recovery process free sulfur is formed by the catalytic reaction between SO_2 and H_2S. The H_2S feed to the plant has been obtained by previously removing the H_2S from hydrocarbon streams by means of a separation method (such as amine absorption).

Compliance with regulations applicable to sulfur recovery plants will be determined by comparing the allowed emission limit in units of pounds of sulfur dioxide per pound of sulfur processed with the actual emission rate determined by stack testing. The concentrations of SO_2, SO_3, H_2S, and any other sulfur compounds should be determined by stack testing and their lb/hr. emission rate determined by multiplying the concentrations by the volumetric flow rates. Using the molecular weights of each gas and the molecular weight of sulfur dioxide, the weight ratio that represents the weights of sulfur dioxide with respect to the weight of the gas can be determined. The sulfur processed shall be the weight of all sulfur contained in the input stream to the Claus plant.

4. Metallurgical Industry (coke oven gas combustion)

The coke oven gas generated in the coking process contains large quantities of sulfurous gases, primarily hydrogen sulfide. When coke oven gas is burned as a fuel either in the coke oven as underfiring fuel or in other processing units at the steel plant, or elsewhere, SO_2 is released as a combustion product. The process and controls are discussed in Part V.

Compliance will be determined by comparing the actual H_2S grain loading of the coke oven gas as determined by the USEPA method 11 - "Determination of Hydrogen Sulfide Emissions from Stationary Sources" with the allowed H_2S grain loading as given.

5. Petroleum Refineries

The primary sources of SO_2 emissions resulting from this type of industrial activity are process heaters, catalytic and regeneration cracking units, treating units, flares and decoking operations. These emissions result from the burning of off gases which contain hydrogen sulfide (H_2S) gas and other sulfurous gases, for the purpose of using the fuel heating values and to dispose of excess process gas. The SO_2 emissions resulting from these operations are a function of the sulfur content of the crude oil being processed, the complexity and age of the refinery, and the efficiency of energy use within the operation.

Fuel gas, for purposes of this regulation, will be any gas produced by a process unit within a petroleum refinery and combusted as fuel. Refining off-gas combustion in refinery boilers, process heaters, and flares will be subject to the emission limitation as applicable in the regulations. Also, any combination of fuel gas with another gas shall be considered to be fuel gas. The combustion of process upset gases can be exempt from the regulation should a malfunction occur. EPA will use its enforcement discretion in such cases.

Compliance with this regulation will usually be determined by comparing the actual emission concentration in grains H_2S/dscf as determined by USEPA Method II with the allowed emission concentration units of grains H_2S/dscf. Although the standard limits SO_2 emissions by specifiying a limit on the hydrogen sulfide content of fuel gas combusted, compliance with the standard can be achieved by removing sulfur dioxide from the combustion effluent gases instead of removing hydrogen sulfide from the fuel gas before combustion. In these cases, however, it must be shown that treatment of the combustion gases is as effective in preventing emissions of sulfur dioxide as is removal of hydrogen sulfide from the fuel gas. If the fuel gas undergoes complete combustion first followed by flue gas desulfurization control then compliance will be determined by using Method 6. By converting the SO_2 emission to an equivalent weight of H_2S required to form the SO_2 (using the ratio of their molecular weights 34 lb. H_2S/64 lb. SO_2) and by using the volumetric flow rate of fuel gas being burned, the equivalent actual concentration H_2S in fuel gas (in units of grains H_2S/dscf fuel gas) that would produce the measured SO_2 emission rate (Method 6) can be calculated.

$$\frac{\left(\frac{\text{lb. } SO_2}{\text{Hr.}}\right) \times \left(\frac{34 \text{ lb. } H_2S}{64 \text{ lb. } SO_2}\right) \times \frac{7000 \text{ grains}}{\text{lb.}}}{\frac{\text{DSCF Fuel Gas}}{\text{Hr.}}} = \frac{\text{grains } H_2S}{\text{DSCF Fuel Gas}}$$

This equivalent actual concentration will be compared to the allowed concentration to determine compliance.

6. General Processes

The form of the general industrial process emission standard is in units of lbs. SO_2/ton of actual process weight input. The general process regulation applies to all process sources (as opposed to fuel combustion sources) for which a source specific regulation is not specified. These sources include establishments in the chemicals, primary metals, fabricated metals, petroleum industries, and others.

Compliance with this regulation will be determined by comparing the actual emissions in lb. SO_2/ton as measured by determining lb. SO_2/hr. by using Method 6 (E.P.A.) and dividing by actual process weight (ton/hr.) with the allowed emissions (in lb./ton) determined from the equation contained in the regulation. The process weight, P, will be the total of all materials introduced into the process excluding process air unless it becomes a part of the process weight, but liquid and gaseous fuels and combusion air will not. "The Process Weight per Hour" will be derived by dividing the total process weight by the number of hours in one complete operation from the beginning of any given process to the completion thereof, excluding any time during which the equipment is idle.

7. Catalytic Cracking Units

Emissions from these units occur during the catalyst regeneration step. In the cracking operation, large molecules are decomposed by heat, pressure, and catalysis into smaller, lower-boiling molecules. Simultaneously some of the molecules combine (polymerize) to form larger molecules. Products of cracking are gaseous hydrocarbons, gasolone, gas oil, fuel oil, and coke.

Compliance will be determined by calculating the actual SO_2 emission rate in units of the regulation in lb. SO_2/1000 lb. fresh charging feedstock. A stack test, using the Federal Method 6-determination of sulfur dioxide emissions from stationary sources should be used to determine the lb. SO_2/hr. emitted and then this number would be divided by the charging fresh feedstock rate in units of 1000 lb./hr. This actual value will then be compared with the allowed emission rate in units of lb. SO_2/1000 lb. fresh charging feedstock to determine compliance.

8. Primary Zinc Smelter

Primary zinc production is a sequence of physical-chemical processes that involve the mining and concentrating of the naturally occurring zinc mineral, mostly as sulfide, the preparatory steps that are necessary for reducing zinc to the metal form, the reduction process itself, and the subsequent zinc purification.

This regulation limits the SO_2 emissions from the entire zinc smelter to that prescribed by the equation $Y = 0.564 X^{0.85}$ where X is the total sulfur feed expressed as elemental sulfur in the smelter input stream in lbs/hour and Y is the allowed sulfur dioxide emission rate in lbs/hour. For determining compliance with the regulation, SO_2 emissions from each operation must be summed including roaster and sintering emissions, and then this sum must be compared with the allowed emission as calculated from the equation. The total sulfur feed (lbs./hr) input to the smelter should be determined by sampling all zinc ores used in the process.

Table 3-1 Process Source: Standard Industrial Classification Categories (SICC), Units of Allowable Limit

SICC	Source Category Regulation Type	Units of Limit
2000	General Process - Process weight rate limit	Pounds of SO_2 per ton of process weight (lbs/t)
2990	Petroleum Refinery - catalytic cracking units, flat weight limit on charging stock	Pounds of SO_2 per 1000 pounds of charging stock (lbs/1000 lbs)
2993	Petroleum Refinery - Off-Gas combustion in refinery boilers, process heaters or flares. H_2S oil refinery gas combustion concentration limit.	Grains of H_2S per dry st cubic feet of oil refinery gas (gr/DSCF)
3313	Metallurgical Industry - coke manufacturing H_2S COG combustion concentration limit for coke oven underfiring (COG-coke oven gas)	Grains of H_2S per dry std. cubic feet of COG (gr/DSCF)
3314	Same as 3313 but extends limit to other uses of COG besides coke oven underfiring	Same as 3313 (gr/DSCF)
2820	Sulfur Recovery Production Plant, flat weight limit on product produced	Pounds of SO_2 per pound of sulfur recovered
	Sulfuric acid plant flat weight limit on product produced	Pounds of SO_2 per ton of 100% H_2SO_2 produced
2393	Industrial Process Fuel combustion flat actual heat rate input limitation	Pounds of SO_2 per actual million BTU heat input.
4911 all others	Direct heat exchange fuel combustion limitation sliding scale limit or flat rate 1) Utility Steam generator 2) Industrial Steam generators	Pounds of SO_2 per million BTU actual heat input

SECTION IV

ANALYSIS OF ANALYTICAL RESULTS FOR STRATEGY FORMULATIONS

SECTION IV. ANALYSIS OF ANALYTICAL RESULTS FOR STRATEGY FORMULATION

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SECTION IV. ANALYSIS OF ANALYTICAL RESULTS FOR STRATEGY FORMULATION

INTRODUCTION

As described in Section VIII of this document the analytical methodology chosen for each county was based upon source configuration (i.e. relative location to other sources), type of surroundings (urban or rural) and the physical characteristics of the surrounding terrain (i.e. gently rolling, rough or irregular). The overall analysis can be broken down as urban or rural. The urban analysis includes dispersion modelling and the modified rollback approach. Three urban metropolitan areas, Cleveland, Akrun and Toledo were assesed to have both long term (annual) and short term (3 hour and 24 hour averages) air quality problems. The CDM/CSDFP and RAM models were utilized in these areas to develop an attainment and maintenance strategy. Air quality in the Dayton, Canton, Columbus and Cincinnati metropolitan areas as indicated in the Technical Support Document showed no demonstratable problem with the annual ambient air quality standards. The analysis of these areas, with the exception of Cincinnati, concentrated on assessment of any potential short term problems and the development of a control strategy with RAM. Because of severe terrain irregularities in the remaining urban areas; Cincinnati, Steubenville, and Youngstown the modified rollback approach was used to develop a strategy to attain and maintain both the short term and long term standards. Facilities with tall stacks relative to the surrounding terrain (i.e. power plants) in these area were analyized with the MAXT24 single point source dispersion model. There was a total of 9 metropolitan areas located in or adjacent to 14 urban counties across the state. All major facilities in 41 rural counties (greater than 10 MMBTU/HR rated capacity or greater than 100 tons of sulfur dioxide emitted per year) more analysied with dispersion modelling techiniques where the available data base permitted. The remaining 33 rural counties were designated as not requiring a strategy to meet the ambient air quality standards for sulfur dioxide.

A description of the specifics of each analysis and how the results for each county (urban and rural) were obtained follows.

IV. A. Urban Analysis

1. Cleveland Metropolitan Area (CDM-RAM-CSDFP)

General Description of Urban Area

Cleveland lies on the Southeastern shore of Lake Erie in the Greater Metropolitan Cleveland Intrastate Air Quality Control Region (AQCR). The City has a population of 757,046 (1970) and a total of 1.9 million in the metropolitan area. The counties that are studied here include Cuyahoga, Lake and Lorain. Cleveland is located in Cuyahoga County. Elyria, located west of Cleveland in Lorain County, has a population of approximately 49,500 (1970) people. Painesville in Lake County has a population of 17,200 (1970). Cleveland's industry is built on iron and steel production and affilitate manufacturing. Cleveland is one of the two largest machine tools and industrial equipment manufacturing centers in the nation.

The population density in Cuyahoga, which is the heaviest of the three, is about 3033 residents per square mile. Cleveland's population density is 9,800 per square mile. Lake County has approximately 700 residents per square mile and Lorain has 500 residents per square mile. The major growth in this area over the next ten years is projected to be centered in Cuyahoga and Lake Counties.

The terrain in Cleveland area is generally level. However, the Region contains some hills and several valleys which effect the local dispersion of air pollutants. The Northern part of the area lies along the lake front and is very markedly affected by the modifying influence of Lake Erie.

The most important land features in relation to air quality distribution are the Cuyahoga River Valley and the ridge on the Southeastern edge of Cleveland. The narrow North-South valley approximately bisects the City of Cleveland. The valley assumes added importance since it is the location of several large pollution sources. The ridge rises rather abruptly from 600 to 1,000 feet and presents somewhat of a barrier to pollutants emitted at low elevations during periods of stable atmosphere conditions.

To some extent, weather features in the Cleveland area are influenced by the modifying effects of Lake Erie. The Lake has a cooling effect during the warm season and has a reverse effect during the cold season. The most prominent lake effect is the lake breeze, which is prevalent during the daylight hours in Spring and Summer, when the water temperature is usually considerably colder than the land. The resultant lake breeze cause complex modification in vertical stability structure. Also, the wind flow brings in relatively clean air from over the lake, displacing the pollution toward inland locations.

A summary of the sulfur dioxide monitoring sites and the data obtained for 1973 and 1974 are listed in Appendix G by AQCR and county. A total of sixteen of the eighteen monitors located in Cuyahoga County met air quality assurance validify checks for the 1974 Climatological Dispersion Model (CDM) calibration year. The maximum measured annual arithmetic mean for 1973 was 78.3 micrograms per cubic meter measured at 4150 E. 49th Street (UTM's 444.8, 4588.2) in Cleveland. The highest measured second maxmum 24-hour concentration that year was 215 micrograms per cubic meter, measured at 1910 W. Blvd. (UTM's 437.2, 4592.0) in Cleveland. In 1974, the annual ambient air quality standard was violated when the site located at East 22nd and Woodland (UTM's 443.5, 4593.5) reported an annual arithmetic mean of 99.5 micrograms per cubic meter. The highest second maximum 24-hour concentration that year was 334 micrograms per cubic meter, measured at 1365 East 12th Street

(UTM's 442.5, 4594.8) in Cleveland. A total of eight of the twelve monitors located in Lake County met air quality assurance. Validity checks for the 1974 CDM calibration year. The maximum measured annual arithmatic mean concentrations for 1973 and 1974 were 58.2 and 73.2 micrograms per cubic meter measured at 71 East High Street in Painesville (UTM's 479.8, 4618.7). The highest measured second maximum 24-hour concentration for 1973 and 1974 was 155 and 288 micrograms per cubic meter respectively, measured at school 56 (Hale and Lee Streets) and at Diamond Shamrock's east site D.

Analytical Assumptions and Data Base

Local Climatological data such as mean seasoned day and night time temperatures, the mean yearly temperature, heating degree days, mean heating temperatures (difference between heating degree days and mean seasonal temperature) and empirical data on the variation of residential, commercial and institutional fuel use over a mean 24 hour seasonal day were used to address diurnal variations in area source emissions. The data used for estimating the variation of fuel use from factors other than temperature were taken from a study of fuel use of space heating in St. Louis (D.B. Turner, 1968)(1) Diurnal variation of emissions from area sources were accounted for in a similar fashion in the Toledo and Akron studies. These factors were utilized in the CDM Analysis.

The estimation of the height of rise for non-bouyancy-dominated plumes was made by comparing the rise calculated by the Briggs plume rise expressions with those calculated by Stunke(2) or Rupp(3) and selecting the rise that gave the highest effective stack height(4). Of the eight to ten stacks examined in the Cleveland inventory 4 or 5 required plume height corrections to better account for momentum flux attributed to the relatively cool stack temperatures and high exit velocities.

As was noted in the public comment discussion the area source emission grid for Lake County did not adequately cover the area being modeled. This oversite was corrected by expanding the grided region to cover all of Lake County. The same method as described in the original Technical Support Document for apportioning area source emissions to grid squares was used in the expanded Lake County grid.

A description of the modification made to the base year emission inventory in Cleveland and how the new data were collected and compiled can be found in Section II. A detailed description of the CDM, CSDFP and RAM metholology used for control strategy development in the Cleveland Metropolitan Area can be found in Section VIII. The description of each model is located in Section IX.

Final Results

A total of 24 air quality monitoring sites were used for calibrating the predictions made by CDM in the Cleveland metropolitan area. A very acceptable correletion of 0.83 was obtained in comparing model predictions at the same location of observed air quality data. The emission inventory data, air quality data and meterological data used in the model calibration were for the common base year of 1974. The improved quality of the point and area source emission inventories and the additional quality assurance checks of the air quality data base (verification corrections to old data and the use of additional verified data) are the probable reasons for the improved correlation between predictions and observations. A net correlation coefficient of 0.83 was obtained compared with the 0.77 coefficient obtained in the Cleveland calibration analysis for the proposed regulation(5). Separate slopes for point and areas sources were obtained in the multiple regression analysis. The point source slope was 0.61 and the area source slope was 1.86 compared with an overale slope for point and area sources of 0.63 obtained in the proposal analysis. The regression intercept was 16.76 micrograms per cubic meter. A summary of the multiple regression analysis including the calculated point and area source concentrations and the observed concentration at each of the 24 monitoring sites are given in Table IV.A.1-1. The computer output from the calibration run including the base year input data are given in Appendix A of volume II.

Projections of ambient annual air quality to 1985 and estimates of critical 24 hour and 3 hour sulfur dioxide concentrations were made using the CDM and RAM models respectively. Emission inventories for projected 1985 source operations along with the meterological and receptor data input to CDM for determining compliance with the annual standard, plus the results of the unregulated and regulated estimated annual air quality are contained in Appendix A. In addition, contained in Appendix A are the emission inventories used in the unregulated RAM runs for each of 7 regions comprising the three county Cleveland metropolitan area. Because of the large number of sources in the emissions inventory the study area had to be divided into 7 subregions to adequately address source-specific impact and develop source-specific regulations

The highest predicted annual mean concentration estimated to occur in 1985 was 165.0 micrograms per cubic meter located at the UTM easting of 444.4 kilometers and UTM westing of 4588.6 kilometers. Sources having the most significant impact on this receptor were the United States Steel (USS) Cuyahoga works (boiler numbers 1 thru 7 connected to 7 separate stacks). These stacks were projected to contribute

LEAST SQUARES REGRESSION ANALYSIS 1974

TABLE IV.A.1-1 CLEVELAND

SAROAD NO.	CDM NO.	CALCULATED Area ug/m^3	CALCULATED Point ug/m^3	OBSERVED (ug/m^3)	MULTIPLE REGRESSION COEFFICIENTS M_p	M_A	b ug/m^3	r	S_z^2	σ^2	n
36-1300-013	1	6.0	82.8	77.0	0.61	1.86	16.76	0.83	954.73	3065.88	24
36-1300-009	3	4.1	32.9	51.1							
36-1300-001	4	4.4	57.1	57.1							
36-1300-005	5	3.1	69.0	42.3							
36-1300-003	6	3.0	50.9	40.0 *							
36-1300-011	7	4.0	25.7	48.6							
36-1300-010	8	1.7	29.3	34.0							
36-1300-008	9	3.8	77.7	82.4							
36-1300-012	10	8.1	62.1	68.5							
36-1300-033	11	2.9	114.6	99.5							
36-1300-007	12	2.8	19.9	33.7							
36-1300-026	13	1.0	106.9	84.1							
36-1300-027	15	3.7	32.2	62.4							
36-1300-017	16	8.3	49.1	52.0 *							
36-1300-021	17	3.0	28.8	42.1							
36-1300-029	18	2.8	52.9	73.1							
36-1880-002	19	0.7	33.9	39.7							
36-3280-003	21	0.2	34.4	30.8							
36-3280-001	23	2.6	39.9	38.8							
36-7480-001	24	0.8	42.8	42.1							
Brine Resv.	25	1.0	39.0	41.6							
Tech. Center	26	1.0	30.2	28.7							
West	27	0.3	28.8	43.1							
Upstream	29	1.0	37.2	36.8							

where:

M_p = slope for point sources
M_A = slope for area sources
b = Intercept of regression line
r = Coefficient of multiple correlation

S_z^2 = Standard error of estimate

σ_1^2 = Standard deviation of estimate

n = No monitoring sites

approximately 42 percent of the total concentration estimated at this receptor. The receptor site was located approximately 4.3 kilometers South by Southeast of the USS boiler stacks. Up to 15 additional critical source/receptor pairs (i.e., significant source groups having major impact on receptor sites where projected annual violations occur) were examined to determine the source-specific reduction required to attain and maintain the annual ambient air quality standards.

A similar precedure was used in the assessment of any 24-hour and 3-hour violations estimated by RAM. Since the short-term standard required evaluation of discrete sets of critical meterological conditions specific to source configurations and operations, the determination of critical source/receptor pairs and the required source reductions was more involved than the procedure used in the annual analysis.

As described in Part VIII, up to 10 critical source-specific second worst case meterological days for each study region first had to be selected from the analysis of the RAM runs using a full year of meterolocial data. Each region had a different set of critical days selected from the full year runs. Table IV.A.1-2 gives a summary of those critical days selected for each of the seven RAM analysis regions.

Table IV.A.1-3 gives a summary of selected RAM 24-hour critical day results by analytical region.

Comparison of the source-by-source reduction required form both the CDM and RAM computer runs showed that the 24-hour and 3-hour standards were the controlling standards for the majority of point sources. Therefore, the source-by-source emission reduction required were determined primarily on calculations based on the RAM analysis. Strategies for fossil fuel steam generators were determined by plotting

TABLE II.A.1-2
SELECTED CRITICAL DAYS FOR SEVEN RAM REGIONS IN THE CLEVELAND METROPOLITAN STUDY AREA

Region # and Name	Location	Critical Days
1 (LAPA)	Eastern Lake County, Painesville area	22, 24, 33, 38, 51, 153, 256
2 (CUYSCL)	Southern most Cleveland, Paema and Garfield Hts. areas of Cuyahoga County	7,15,34,166,205,251,260, 286,303,304
3 (LORLOR)	Lorain County Including Elyria and Avon Lake	15,27,28,34,51,83,100,124, 141,202,212,223,243,245, 265,298,304,337,345,355
4 (CUYWEST)	Western Cuyahoga Cty.	32,75,181,182,184,201,205, 210,253,289,345
5 (CUYELAKW)	East Cleveland Area and Midwestern Lake County	25,26,34,67,78,146,163,181, 285,289,297
6 (CLE-SOUTH)	Cleveland South	10,34,41,141,153,187,205, 251,288,307
7 (CLE-NORTH)	Cleveland North	Same as #6

TABLE IV.A.1-3
SUMMARY OF SELECTED RAM 24-HOUR CRITICAL DAY RESULTS

DAY NO. / REGION NO.	Concentration minus background ug/m^3	Receptor location (km)		Contributing Sources		Reduction Required %
		X	Y	RAM #	% contrib.	
226(R1)*	825	477.2	4618.13	10	73	77
				3,8,9	27	0
26(R5)	1016	463.86	4613.24	8,9,10	61	76
				11	27	76
				12	11	76
345(R4)	534	435.2	4585.61	139,182	60	33
				140,183	36	33
28(R3)	995	412.2	4595.2	1-4	14	63
				5,6	41	63
				7	27	63
				8	18	63
28(R3)	469	401.57	4590.85	16	54	22
				17	46	22
28(R3)	1700	406.78	4589.26	46	84	83
				47	10	83
				16,17	4	22
187(R7)	676	446.0	4593.0	5,21	30	63
				6,22	25	63
				4	15	63
153(R7)	628			1	43	28
				2	13	28
				4,5,6, 21,22	41	63
153(R6)	1918			25	99	82
251(R7)	610			31-35	39	50
				9,11,12,13	31	50
251(R6)	525			2	17	53
				31-35	16	53
				9,11,12, 13,	22	53

*partial strategy applied.

status quo emission limits (in pounds per million BTU) vs. boiler size (in million BTU per hour); adjusting the status quo emission limits by the amount of emission reduction required at each stack and than fitting a best curve (power law sliding scale) to the resulting plot. Those points outlying the best fit curves were given source-specific emission limitations. The strategy determined from RAM was tested with the CSDFP and CDM to assure compliance with the annual standard. The results of the CDM strategy run are contained in Appendix A.

A brief summary of significant sources which required emission reductions critical to the attainment of the NAAQS in each of the seven RAM analysis areas will follow.

Region 1 is located in the eastern part of Lake County. The emission inventory has a totol of 22 point sources owned by 7 companies. The Diamond Shamrock Chemical plant is the largest facility in the county but is projected to cease operations by the end of 1976. All emissions at Diamond Shamrock was modeled as zero. The Lubrizel plant in Painesville owns 4 stacks connected to one process and 3 boilers. These stacks are ranked first and fourth respectively (Diamond Shamrock not in ranking) with regards to their potential impact for degradation of air quality. Three of their four stacks are identical. Table A.1-3 gives a summary of selected signficant days of RAM results, including the source-specific emisison reduction that the modeling required. Appendix A gives the RAM preprosser program significant point rankings by all point sources in the Region 1 inventory.

Region 5 covers the western half of Lake County and the eastern portion of Cuyahoga County. The emission inventory has a total of 17 point sources owned by 8 companies. The Cleveland Electric Illuminating Company, Eastlake plant is located in the northwest portion of Lake

County near the shores of Lake Erie. This facility is the largest single source of emissions in Lake County. The modeling input parameters for the plant are listed in Appendix A (RAM nos. 7 thru 12). Since the nearest significant point source to the Eastlake plant is over 3.7 kilometers away and the RAM results showed no significant interaction from other sources, a compliance option equation for the six stacks at the plant could be developed. A summary of the results for day 26 (R5) that were used to develop the option equation are given in Table A.1-3. The 24-hour standard was the controlling standard for each of the Eastlake stacks. The modeling results from the remaining 7 companies in region 5 did not show vioaltions of any standards.

Sources in Region 2 are located in the South and Southwest portion of Cuyahoga County. The emission inventory has a total of 5 point sources owned by 4 separate industrial facilities. No power plants are located in Region 2. Allied Chemical was originally analysized in this region, but due to its closer proximity to the Southern portion of the Cleveland city limits, Region 7's boundaries were expanded to incorporate this facility. The remaining four facilities in the region did not have any significant impact on Region 2 air quality.

Region 4 covers sources in the western portion of Cuyahoga County. All but two out of 10 stacks in this region are owned by Ford Motor Corporation (FMC) or General Motors Corporation (GMC). The GMC Parma Transmission plant was modeled without scrubber controls on its four boilers. The RAM and CDM results required reduction in uncontrolled emissions at the plant. The Parma facilities present scrubber configuration would assure attainment and maintenance of both the long and short term standards in the Region.

Region 3 covers all sources located in Lorain County. A total of

47 point sources owned by 6 companies are included in the Region 3 RAM analysis. Two of the plants are utilities owned by the Cleveland Electric Illuminating Company, the Avon Lake Plant and the Ohio Edison Company, the Edgewater plant. The largest industrial facility is the Lorain integrated steel plant owned by United States Steel (USS). GMC, Fisher Body, and FMC, Lorain Assembly Plant, also have operations within the Region 3 study area. The source ranked as having the most significant potential impact on air quality is USS process P033 Stacks at Avon Lake and Edgewater were listed as second thru seventh in the RAM preprocessor significant point source rankings. The critical days that determined the overall reduction at the Avon Lake and Edgewater plants are given as day 28 in Table A.1-3. Since the Avon Lake plant is relatively isolated and no interaction with other facilities were observed at all critical days and significant receptors for those days, a compliance option equation could be developed for Avon Lake. A detailed summary of the RAM modeling predictions used in developing the option equations is contained in Appendix A. Of the 13 boilers in the USS inventory all but 3 were allowed to increase their SO_2 emissions. The most stringent requirements were mandated for USS process heating and coking operations using coke oven gas (COG) as their primary fuel. Process P033 and P039 required over 80% reduction in emissions. The remaining processes using COG had a lesser impact on air quality. Table IV.A.1-3 summarizes a selection of critical day RAM results specific to the process sources. The modeling inventories for a test strategy run for RAM and the unregulated and regulated runs for CDM are contained in Appendix A. Full results of the status quo RAM run and the emission inventory used for this run can be examined in the Region V office. It should be noted that the initial calcualtions of emissions from

processes burning COG were under estimated. Therefore, sources using COG and their air quality contribution had to be corrected to reflect the proper emission rates.

The Cleveland city limits were divided into two separate analysis Regions. Region 6 covered the south half of the city and Region 7 the northhalf. A total of 61 point sources covering 15 separate facilities were located in the two analysis regions. There are two power plants; CEI/Lake Shore plant and the Cleveland Municipal power plant located in Region 7 (North Cleveland). Lake Shore's highest concentration occured on day 187 which required 63 per cent overall emission reduction at the plant. A limited number of emission tradeoffs had to be made at critical receptors where more than 4 or 5 separate faciliteis had a major impact. In those cases where substantial reduction was required (greater than 50%) the general rule was to not require a coal or oil fired units to reduce below new source performance standards (NSPS) if possible. The number of tradeoff were also limited to those sources that did not have signficant point source receptors or were contributing to their significant point source receptors the same degree as critical receptors requiring a more stringent amount of reduction. The Cleveland Municipal plant was considered for a tradeoff because the required reduction at a receptor it was contributing to would require an emission limit below NSPS. However, the plant's most significant receptor (receptor where plant contribution was higher) required an emission reduction a factor of two less after Lake Shore's contribution to that receptor was reduced by its required amount (63% reduction). Cleveland Munys overall reduction was approximately 30 percent, based on critical day 153 in Table IV.A.1-3. Republic Steel has the largest industrial complex in Regions 6 and 7. A total of 38 point sources were included in the inventory. Twelve miscellaneous sources at the facility could not be modeled as point sources because of the fugitive nature of their emissions. These sources listed in Table IV.A.1-4 were modeled as area sources. The Republic Steel inventory was updated with information supplied thru the public comment period(5). The complete inventory used for the RAM and CDM models are given in Appendix A. Table IV.A.1-5 gives a list of source operations that were projected to phase out of operations in 1985. Table IV.A.1-3 gives a summary of RAM predictions and required emission reductions for selected boilers and processes at Republic Steel.

Allied Chemical's sulfuric acid plant in Region 6 required a 82 percent reduction based on critical day 153. The plant is ranked as the most significant point source in both Regions 6 and 7. Other facilities where significant reductions were required Dupont Chemical, Sulfuric Acid Plant 63% reduction, Alcoa 67% reduction, and Independent Towel 42% reduction.

An overall strategy was then formulated considering the critical reduction needed to attain the short term standards and this strategy was then applied to the CDM inventory to determine if the annual SO_2 Standard would be met. The final strategy selected assured attainment and maintenance of both the short and long term standards. The overall reduction in emission from all three counties total 12,500 grams of sulfur dioxide per sec or 434,000 tons per year. The strategies promulgated for Cuyahoga, Lake and Lorain Counties can be found in Parts (23), (35) and (38) of the regulation.

TABLE IV.A.1-4

Area Source	Emissions
Miscellaneous Basic Oxygen Furnace Shop	39.6 gm-sec^{-1}
Foundry	16.2 gm-sec^{-1}
Miscellaneous Blast Furnace #1	21.3
Miscellaneous Blast Furnace #4	20.1
Miscellaneous Blast Furnace #5	27.4
Miscellaneous Blast Furnace #6	27.4
P Anneal 1-4	28.0
Car Thaw 1-1 through 1-4	14.4
Car Thaw 1-1 through 2-4	6.8

TABLE IV.A.1-5

PROJECTED SOURCE PHASE OUTS BY 1985

Facility	CDM #	Source Description
Diamond Shamrock	110	B001, Boiler #33
"	111	B002, Boiler #34
"	112	B003, Boiler #35
"	113	B004, Boiler #36
"	114	B005, Boiler #1
"	115	B006, Boiler #2
"	116	B008, Boiler #4
"	117	B009, Boiler #5
"	118	B012, Boiler #6
"	119	B013, Boiler #7
"	120	P028, #4 Lime Kiln
"	121	B007, #3 Lime Kiln
Republic Steel	55	P028, 29, OH PRECIP 111
"	56	P030, 31, OH PRECIP 112
"	63	P039, 98 in. Slab Furnace #1
"	64	P040, 98 in. Slab Furnace #2
"	65	P041, 98 in. Slab Furnace #3
"	66	P042, 98 in. Slab Furnace #4
"	67	P043, 98 in. Slab Furnace #5
"	68	P046, 84 in. Slab Furnace #1
"	69	P047, 84 in. Slab Furnace #2
"	70	Sinter Plant

Section IV - REFERENCES

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2. H. Stumke, Suggestions for an Empirical Formula for Chimney Elevations Staub 23: 549-556 (1963), USAEC ORNL-tr-977

3. A.F. Rupp, etal. Dilution of Stack Gases in Cross Winds, USAEC AECD-1811 (1948)

4. Personal Conversations with G.A. Briggs

5. Examination of Alternatives for Achieving Sulfur Dixoide Ambient Air Quality In The State of Chio Vol 1 Arthur D. Little Inc., Report to Jones, Day, Reavis and Pogue in behalf of Republic Steel April 5, 1976.

2. Toledo Metropolitan Area

General Description

Toledo is located in the Northeast section of Ohio bordering on Michigan and adjacent to Lake Erie (AQCR Number 124). Toledo is the fourth largest city in Ohio with a 1970 population estimated at 385,000 people. The population density of Lucas County, in which Toledo is located, is 3000 inhabitants/square mile, and the city itself has 4700 inhabitants/per square mile.

The Toledo study area is relatively flat. Elevations range from 570 feet (above mean sea level) at lake level to 700 feet inland. Toledo stands along both banks of the Maumee River, near the point where the river widens to form Maumee Bay at the western end of Lake Erie. The valley formed by the Maumee River is an axis for the topography. The slopes of the valley are very gentle, ranging from 3 to 7 feet per mile, except for the river bank which is about 30 feet.

Lake Erie has a moderating effect on the weather in Toledo. Extremes in temperature are seldom recorded. Predominant winds are from the west southwest to south southwest in Lucas County. The potential of vertical dispersion is highest during summer afternoons, but dispersion is restricted during the mornings throughout the year. In general, the topography and meterology in the Toledo Area tend to relieve rather than aggravate the air pollution problem.

The Toledo metropolitan area, which includes Lucas and Wood counties for the purpose of this study, is a heavily industrilized portion of Ohio that has several major emitters of SO_2. The basic industries associated with the Toledo area include the production of glass, petroleum refining, the production of transportation equipment and parts, and the manufacture of scales and machine tools. There is a total of 144 point sources of SO_2 in the Toledo metropolitan area. A total of 30 sources are owned by twenty-one separate companies in Lucas County, Libby-Owens Ford and Bowling Green State University own 6 stacks in Wood county with the remaining point sources located just north of the city in Monroe county Michigan.

The Toledo area, Lucas county in particular, is an Air Quality Maintenance Area (AQMA) for SO_2. Air quality measurements for the base year (1973) that were used in the calibration show violations of the annual standard (see Appendix G, Air Quality Data) for SO_2.

Data Base Modeling Assumptions and Methodlogy

A description of the collection, verification and compilation of the emission inventory, meterological and air quality data base utilized in the analysis is described in Section II of the document. General assumptions made in the preparation of data for modeling are given in Section VIII. A listing of input data to CSDFP, CDM and RAM is given in Appendix A.

The overall methodology including the procedures used to calibrate CDM (annual analysis) in the analysis of the Toledo Metropolition area is described in Section VIII of the document.

Summary of Final Results

The results of the multiple linear regression for calibration of CDM are given in Table IV. A. 2-1. The equation of best fit for measured vs. calculated concentrations is:

$Z_c = 1.58Y_A + 0.63X_p + 13.72$. A total of 9 Air Quality monitoring sites were used for the calibration. A very acceptable correlation coefficient of 0.85 was obtained in comparing model predictions with available observations.

The CDM base year inventory used to obtain the results in the CDM calibration are contained in Appendix A.

TABLE IV. A. 2-1 - Toledo Least Squares Multiple Regression

SAROAD No.	CDM #	Calculated			Observed	Multiple Regression Coefficient					
		Area ($\mu g/m^3$)	Point ($\mu g/m^3$)	Total ($\mu g/m^3$)	$\mu g/m^3$	M_p	M_A	b ($\mu g/m^3$)	r	S_z^2	σ_1^2
36-5200-001	1	5.9	90.5	96.4	89	0.71	1.58	13.72	0.85	962.6	3537.89
36-6600-009	2	21.8	15.7	37.5	74						
	3	20.5	31.9	52.3	94						
36-6600-001	4	26.0	31.9	57.9	68						
23-3580-020	5	5.1	15.3	20.3	41						
23-3580-021	6	1.2	10.8	12.0	33						
	7	1.2	4.7	5.8	15						
	8	7.3	16.5	23.8	15						
36-6600-007	9	20.1	30.3	50.4	42						

M_p = Slope for point sources

M_A = Slope for area sources

b = Interecent of regression line

r = Coefficient of multiple correlation

S_z^2 = Standard error of estimate

σ_1^2 = Variance of estimate

Analysis of the results from the CDM modeling, including the unregulated 1985 projections along with the results of the strategy run are contained in Appendix A. The RAM analysis in Toledo as in the Cleveland metropolition area required spliting Toledo into four analytical regions. The sources in each of these regions along with their respective emission inventories can also be found in Appendix A of Volume II.

The CDM results for Toledo showed a maximum concentration at receptor number 238. Approximatly 80% of the contribution to this receptor was from two facilities, Standard Oil Refinery and Coulton Chemical. Several other receptors also had quite high concentrations predicted and the contribution did not come always from these two facilities. The receptor number 238 is approximately .5 km to 1.0 km away from the source at Standard Oil and Coulton Chemical UTM coordinates are given in Table IV. A-2.

The RAM results for Toledo show violations of the short term standards. The results are summarized in Table IV. A. 2-2. The background concentration for the short term was 15 ug/m^3. When the final results were tabulated the RAM results were found to be critical in determining the strategy for Toledo. Appendix A contains the output from the RAM preprosser program for the four Regions modeled in Toledo. This output contains the point and area source inventories and tables giving a ranked listing of point and area sources.

Table IV. A. 2-2 - Toledo Summary RAM Results

Facility	Region	RAM Nos.		Critical Day	Receptor Number	Source Conc.	Total Conc.	X_T Rec. Conc.	% Reductio Required
Toledo Edison Bayshore	R1	1 to 5		111	3P17	194	1613	1625	79
Toledo Edison ACME	R2	1 to 4	1 3&4	318 87	46P42 27P17	12 168	192 746	448 961	49 63
Toledo Edison Water St.	R2	27 to 34	32&33	318	28P17	22	332	560	63
SOHIO	R1	6 to 19		135	41P19	1577	1623	1630	79
Coulton Chemical	R1	20 to 23	20 21to23	111 135	3P17 5P13	19 45	1613 1636	1625 1642	79
Gulf Oil	R2	5 to 26		87	27P17	499	746	961	82
Phillips Petroleum	R2	35 to 39		87	23P37	206	381	567	57
Sun Oil	R4	7 to 9 11 to 16 22 to 35		310	5	585	585	723	78
Interlake	R2	40 to 43		87	27P17	47	746	961	82
Toledo Ment. Hosp.	R4	1 to 3		310	1	531	531	538	66
Allied Chemical	R4	4 to 6							
Nabisco	R2	44 to 47							
Seneca Petroleum	R4	124							

Toledo Edison - Bayshore, Acme, & Water Street

CDM Numbers	1 to 5,	6 to 10,	63 to 70
RAM Numbers	1 to 5,	1 to 4 ,	27 to 34
	R_1	R_2	R_3
	Bayshore	Acme	Water St.

The Bayshore Power Plant located in Region 1 (R1) of the study area for Toledo is a major coal burning facility. There are five units located at the Bayshore Plant, 4 of the large units are coal fired and the fifth is a oil fired peaking unit. The total annual emissions for the plant are 1756.6 g/sec of SO_2. Maximum emissions for all five units are calculated to be 2100.5 g/sec of SO_2. Most of the emissions of SO_2 comes from the coal fired boilers. The regulation that was specifically developed for the Bayshore Plant limited the coal fired units to emissions of 1.3 lb of SO_2/MBTU and for oil fired units, 1.0 lb of SO_2/MBTU. The reduction required was determined from the critical day III RAM run. The 79% reduction required was the result of this analysis.

The Acme Power Plant is located in the Region 2 (R2) of the study area for Toledo has two relatively small oil burning units and two large coal fired steam generating units. The total annual emissions from the plant are 1384.0 g/sec of SO_2.

The regulation that was specifically developed for the Acme Power Plant limits the emissions from coal fired boilers to 2.0 lb of SO_2/MBTU and for oil fired units to 0.8 lb of SO_2/MBTU.

The RAM analysis which led to this emission limitation evolved from allowable emissions calculated from critical day runs Number 318 for the oil fired units and Number 87 for the coal fired units. The total concentration for day 318 and day 87 respectively were 448 and 961 ug/m³.

The Water Street Station located in Region 2 (R2) of the study area for Toledo is basically a steam heating plant supplying the downtown building with steam for heating. The boilers are oil fired but coke oven gas is utilized as an additional fuel source. The combined annual emissions of all units at the facility are 59.7 g/sec of SO_2. The regulation that was specifically developed for the Water Street Station limits the emissions to 0.8 lbs of SO_2/MBTU.

Standard Oil of Ohio (SOHIO) - Toledo Facility

CDM Numbers		9 to 23
RAM Numbers	R1	6 to 19

The Standard Oil Company of Ohio (SOHIO) facility in Lucas County is a major contributor of Sulfur Dioxide Emissions. There are thirteen separate sources of emissions at this particular facility. A majority of the sources are process heaters which are used in the refinery operation. The remainer of the sources are various processes. The total annual unregulated emissions from the facility amount to 573.1 g/sec of SO_2. The regulation that was specifically developed for the sources at Standard Oil limit emissions of SO to .5 lb SO_2/MMBTU for process heaters, 46 gr. H_2S/100 DSCF for refinery off gas combustion, .3 lb SO_2/1000 lb charging stock for catalytic cracking units and .11 lb SO_2/ton input for general processes.

COULTON CHEMICAL

CDM Numbers		71 to 74
RAM Number	R1 -	20 to 23

The Coulton Chemical Plant has four sources that contribute SO emissions to the atmosphere. Two of these sources are processes and two are boilers. The total annual emissions amount to 38.1 g/sec of SO_2. The regulation that has been developed for this facility limits that SO_2 emissions to .3 lb SO_2/MMBTU for the boilers and 6.5 lb SO_2/ton of 100% acid for the sulfuric acid plant.

Gulf Oil

CDM Numbers 24 to 45

RAM Numbers R2 5 to 26

The Gulf Oil Refinery in Lucas County has 22 sources of Sulfur Dioxide emissions at this facility. 20 of the sources are process heaters or boilers, one catalytic cracking unit and one sulfur recovery plant. The annual unregulated emissions amount to 159.1 g/sec of SO_2. The regulation that was specifically developed for the sources at the Gulf Oil facility limit emissions of SO_2 to .3 lb SO_2/MMBTU for process heaters, .3 lb SO_2/1000 lb of charging stock for catalytic cracking units, and 32.2 lb SO_2/1000 lb of sulfur processed for sulfur recovery plants.

Phillips Petroleum-Philback Plant

CDM Numbers 75 to 79
RAM Numbers R2 35 to 39

The Phillips Petroleum-Philback Plant has five sources operating at the facility which contribute SO_2 emissions to the atmosphere. Two of the sources are oil fired CO Boilers, one source is an incinerator, and two other sources are process dryers. The annual emissions from the facility amount to 86.5 g /sec of SO_2. The regulation that was specifically developed for

Phillips Petroleum limits emissions from the boilers to 0.8 lb SO_2/MMBTU, 5.49 lb SO_2/ton for the incinerator, and 0.8 lb SO_2/MMBTU for the process dryers.

Sun Oil

CDM Numbers 46 to 48 & 134 to 139 & 49 to 62

RAM Numbers R4 7 to 9 & 11 to 16 & 22 to 35

The Sun Oil Refinery in Lucas County has 23 sources of emissions of SO_2 within the facility. 17 sources are process heaters or boilers, 5 sources are catalytic cracking units and 1 source is a process. The annual emissions from the plant amount to 265.2 g/sec of SO_2. The specific regulation developed solely for Sun Oil limits all boilers or process heaters to .5 lb SO_2/MMBTU, and 2.0 lb SO_2/ton input for the process.

Interlake

CDM Numbers 93 to 96

RAM Numbers R2 - 40 to 43

The Interlake facility is comprised of 4 point sources, 3 boilers and one process. The total annual emissions from this facility amount to 9.8 g/sec of SO_2. The specific regulation developed for this facility limits emissions to .8 lb SO_2/MMBTU for boilers and 4.93 lb SO_2/ton for the process.

AMC

CDM Numbers		80 to 89	108 to 109
RAM Numbers	R3	1 to 10	19 to 20

There are two separate facilities of AMC in Lucas County. The first facility consists of 10 sources of SO_2 emissions from coal fired boilers, and the second facility has two sources of SO_2 emissions which are also coal fired boilers. Annual emissions from the first facility amount to 32.4 g/sec of SO_2 and from the second facility 2.0 g/sec of SO_2 is emitted. The general regulations, 1.5 lb SO_2/MMBTU, for all coal fired boilers in Lucas county applies to AMC.

Toledo Mental Hospital

CDM Numbers		90 to 97
RAM Numbers	R4	1 to 3

There are 8 sources of SO_2 emission within the facility. Three of the sources are coal fired boilers, four sources are oil fired and one source is an incinerator. Total annual emissions from the facility are 36.1 g/sec of SO_2. The general emission regulation for coal and oil fired boilers, 1.5 lb SO_2/MMBTU and 1.0 lb SO_2/MMBTU respectively, applies to the Toledo Mental Hospital.

Allied Chemical - Plastics

CDM Numbers 98 to 100
RAM Numbers R4 98

The Allied Chemical Corp. - Plastics Division in Lucas county has three sources which emit SO_2 within the facility. The annual emissions from the plant amount to 5.3g/sec of SO_2. The general regulation for oil fired boilers in Lucas County applies to Allied Chemical in this case, 1.0 lb SO_2/MMBTU.

General Mills

CDM Numbers 101 to 103
RAM Numbers R3 12 to 14

General Mills has 3 sources within the facility which emit Sulfur Dioxide, all three sources are oil fired boilers. Annual emissions from the facility amount to 3.6 g/sec of SO_2. The general regulation pertaining to oil fired boilers in Lucas county applies to the sources at General Mills.

Doehler - Javis Div.

CDM Numbers 104 to 107

RAM Numbers R-3 15 to 18

The Doehler - Javis Div. has 4 sources of SO_2 within the facility. These sources are coal fired boilers. Annual emissions from the facility amounts to 3.9 g/sec of SO_2. The general regulation for coal fired boilers, 1.5 lb SO_2/MMBTU, in Lucas county applies to the Doehler - Javis Div.

Toledo Hospital

CDM Numbers 110 to 112

RAM Numbers R3 21 to 23

The Toledo Hospital facility has 3 boilers as sources of SO_2 emissions. The annual emissions from these sources amount to 1.9

g/sec of SO_2. The specific regulation developed for the Toledo Hospital facility limits the emissions to 3.5 lb SO_2/MMBTU for the boilers.

City Auto Stamping

CDM Numbers 113 to 114
RAM Numbers R3 24 to 25

There are three coal fired boilers which are sources of SO_2 at the facility. Annual emissions amount to 1.0 g/sec of SO_2. The general regulation for coal fired boilers in Lucas county applies to City Auto Stamping, 1.5 lb SO_2/MMBTU.

Mercy Hospital

CDM Numbers 116 to 118
RAM Numbers R3 - 27 to 29

There are three oil fired boilers that are sources of SO_2 emissions at the facility. Annual emissions of the facility as a whole amount to 1.2 g/sec of SO_2. The general regulation for oil fired boilers in Lucas county, 1.0 lb SO_2/MMBTU, applies to the Mercy Hospital facility.

Nabisco

CDM Numbers 119 to 122

RAM Numbers P2 - 44 to 47

The Nabisco Flour Mills facility has 4 sources of SO_2 emissions which are all classified as boilers. The annual emission rate of the sources at the facility amount to .4 g/sec of SO_2. The specific regulation that applies to Nabisco limits emissions from the boilers to 1.2 lb SO_2/MMBTU.

Seneca Petroleum

CDM Number 124

RAM Number R4 - 7

Seneca Petroleum has one source operating at its facility in Lucas county which emits SO_2. Annual emissions from the facility amount to .2 g/sec of SO_2. The regulation which was developed specifically for Seneca Petroleum limits the emissions from boilers or process heaters to 1.5 lb SO_2/MMBTU.

The specific regulations promulgated for Lake and Wood counties can be found in paragraphs (39) and (65) in the regulation.

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3. Akron Area

General Description of Area

Akron is located in the Northeast portion of Ohio just south of Cleveland, and is about 40 miles from Lake Erie. Akron is in the metropolitan Cleveland Intrastate AQCR in Summit County. The population of Summit County is 540,100 people (1974) with a population density of 1308 residents/per square mile (1970). Summit County covers approximately 413 square miles of the State of Ohio. The City of Akron has a population of 275,420 (1970) residents within the 54 square mile city limit area. The population density of the metropolitan Akron area is 2,667 people per square mile covering a 204 square mile area. Other high density population centers in the area include Cleveland, Canton, and Youngstown. The areas in between these population centers have lower population densities, but they are growing rapidly.

The terrain in the Akron area is generally level. The elevations of the area range between 1000 ft. and 12000 ft. There are several lakes in the area and the Cuyahoga River runs through the City. While there seem to be few physical characteristics of the topography that would effect the dispersion of air pollutants, there may be localized areas, especially along the river that may trap air pollutants.

The basic industry in Akron is rubber and rubber products. The industry is also prevalent in the surrounding area within the County. The total of approximately 40 fuel combustion point sources and 5 industrial process point sources are located in the Summit County study area.

The general weather features in the Akron area are those conditions which exist in most other level terrain sections of Ohio that are not located too close to a large body of water, such as Lake Erie.

A total of 45 point sources and 273 area aources were included in this study. The base year emissions in the region totaled 139,675 tons of SO_2 per year for point sources and 30,939 tons of SO_2 per year for area sources. With the application of specific Standard Industrial Classifications growth rates (see Section VII) the projected unregulated 1980 and 1985 emissions totaled 217,649 and 222,064 tons of sulfur dioxide per year respectively. This represents a 30 per cent increase in emission from the 1973 base year. A description of the emission inventory collection and compilation can be found in Section II. Appendix A contains the base year and projection year emission inventories used in conjunction with the CDM analysis and the design emission inventory used with the RAM analysis.

Section VIII presents a discussion on the overall air quality dispersion model methodology utilized in Akron Summit County analysis. A description of both the RAM and CDM Models can be found in Section IX.

A number of air quality monitors have been reporting sulfur dioxide concentrations in Akron. Of these one is a continous monitor, the others are of the Federal Reference Method. Data collected for 1974 indicated no excursions of the annual standard for sulfur dioxide (EPA-4501-76-001). Similarly, the same monitors recorded no 24-hour concentrations in excess of the respective standard. The continuous monitor was operated for less than five per cent of the year and its output could not yield an annual average. The results from this monitor did show the three-hour secondary standard being exceeded twelve times during the monitor's period of operation, and the 24-hour standard being exceeded by more than double the respective standard. Thus, in the limited period of the continuous monitor's operations, there eixsts an indication that attainment of the short-term standard is a problem in Akron.

The public comments from the city of Akron yielded a substantial amount of air quality data for a two year period. Annual average for the years 1974 and 1975 were submitted for five sites in Akron. The data is listed below:

Site Number (RAPCA)	1974	1975	Change
2	30.5	48.3	+17.8
3	45.2	48.0	+ 2.8
5	43.3	56.4	+13.1
7	28.0	42.5	+16.5
28	49.2	57.4	+ 8.2

In all cases, annual concentrations have increased and in three cases by a value greater than 20%. While two years of data should not be used to demonstrate a long-term trend in air quality concentration, the data certainly suggests that perhaps the emissions increased in the two years indicated. Also, in considering the use of these data certain qualifications regarding the collection of it must be made; they inlcude the assumptions that the data represents a continuous time period with no significant gaps. It is assumed that the monitor is not unduly influenced by a dominant source, and that the monitor has not been relocated during the period of consideration.

An additional air quality trend analysis for Akron, based on data submitted by the State to the NADB, is located in Appendix G of this document. The time period studies in that anlysis is from 1973 to 1974.

Final Results

Both linear and multiple regression analysis were performed to

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calibrate the CDM model in Akron. The statistical analysis of predicted versus measured air quality data at 7 available monitoring sites produced a negative slope with a multiple regression. However, a better net correlation coefficient was obtained with a linear regression, therefore, the latter was applied in Akron for calibration purposes. A summary of predicted versus observed air quality is given in Table IV A. 3-1. The final analysis produced a correlation coefficient of 0.85 and a linear regression equation expressed as: $y = 0.47X + 22.0$.

A description of the calibration procedure is contained in Section VIII.

Results from the CDM analysis indicated no violations of the annual ambient air quality standard. Strategy development was, therefore, based on any excursions of the short term standard as modeled by the RAM. As referenced in Section VIII, a full year of meteorological data was used to identify critical days of worst-case meteorology associated with the most significant point sources. These days were further analyzed to identify the critical receptors for the most significant point sources and the source contributions to these receptors.

The next step in strategy analysis is to tabulate the predictions which exceed the standards, and identify the sources significantly contributing to the cause of the excursion. In most cases the excursion resulted from the combined effect of three or more sources contributing 25% or greater to the excursion. In several cases, eight to ten sources were noted to have caused an excursion with each source contributing from 5 to 15 per cent of the total. A procedure, described in the Methodology Section of this document, was then carried out to calculate a reduction factor for each of the sources contributing to a specified

LEAST SQUARES REGRESSION ANALYSIS
TABLE IV.A.3-1

AKRON - 1973

SAROAD NO.	CDM NO.	CALCULATED (ug/m^3)	OBSERVED (ug/m^3)	LINEAR REGRESSION COEFFICIENTS					
				m	b (ug/m^3)	r	S_{yx}	S_o	S_1
	1	14.46	29						
36-0360-001	2	41.47	40	0.47	22.0	0.85	8.28	7.06	0.13
36-0060-002	3	66.86	54						
36-0060-004	4	76.00	71						
36-0060-006	5	59.02	42						
	6	13.23	32						
36-0060-014	7	66.96	44						

receptor.

The reduction factors were then applied to the status quo fuel quality emission limitation in order to determined a new lower emission limitation. The result of this application was the establishment of a curve such that when it was applied to sources of the appropriate size, the curve would describe the sources new emission limitation. This first strategy test was run at 2.1 pounds of sulfur dioxide per million BTU's per heat input for sources greater than 300 million BTU per hour. For sources less than this size, a "sliding scale" was established from 7 pounds of SO_2 per million BTU heat input for sources of 10 million BTU per hour to 2.1 pounds of sulfur dioxide per million BTU heat input for sources up to 300 million BTU. The results of this strategy test indicated that excursion of the standard, while not extreme, still occured, and that additional control or reductions in emissions were required. The final strategy selected included a sliding scale from 7.0 pounds of sulfur dioxide to 1.8 pounds at the same limits listed above, plus a flat rate of 1.8 pounds of sulfur dioxide per million BTU for source 300 million BTU and greater.

The strategy for Akron is based on predicted excursions of the 24-hour standard indicated by RAM disperion modeling. A full year RAM run identified the days on which frequent excursions of the standard would occur. These days were further analyzed in greater detail to determine the extent of the excursions. The detailed analysis of the five critical days provided a source contribution table which identified the extent of emissions from each source and labled the source as a signficant contributor to a 24-hour excursion. Information regarding the 3-hour standard is also predicted in the critical day analysis.

For fossil fuel-fired boilers, there are a number of sources which have been given individual emission limitations (see table) because they pose a significant impact on certain receptors or their impact was minimal. It should be noted here that the specified emission limitation can mean an emission reduction or emission being held to a status quo.

The five critical days selected for the detailed analysis were days 25, 48, 53, 270 and 288. A summary of the results obtained from these runs are contained in table IV.A.3-3. While all five days were examined, day 270 was selected as the day from which the reduction factors are developed because of the variety of source interacting on a receptor. In certain cases, the contribution of all sources within a facility were not identified as significant contributors to a given receptor in spite of the fact that the magnitude of emissions are equal for each point of emission in the facility. There are two reasons why this occured. First, a source may not show up in the contribution table because of the limitations inherent in the RAM program which picks out only RAM program which picks out only·a certain number of significant sources contributing to a specified receptor. A more detailed discussion of the source contribution table is found in Section VIII. The second reason that an equal magnitude source within a facility may not appear in relation to other sources would because of the differences in physical parameters about the sources. It is fairly certain however, that the magnitude of the excursion of the standard would be the same-the only exception being perhaps that a different point of emission within a facility would be identified as the significant contributor.

Source Discussion: B. F. Goodrich

Facility emission rates for RAM input are developed from PSEDS and Emission Confirmation Reports. The emission rates represent the design

TABLE N.A.3-2.
SUMMARY OF SUMMIT COUNTY REGULATION

Sources for which a specific emission limitation has been developed are listed below.

CDM/RAM#	Company	Emission Limitation pounds per million BTU
16,17,18,19	Diamond Crystal	6.1
27,28	Akwell	3.6
30,31	Ohio Brass	4.2
32,33	Seiberling	1.0
9,10,11	Firestone	1.5
13	BFG	1.9
6,7	Goodyear	1.0
43,44	Tecumseh	1.7
45	Tecumseh	0.7
20,21,22	Ohio Edison Beech	4.1
37,38	Ohio Edison Gorge	2.1
23	PPG*	17 pounds per ton
25	3-M	17 pounds per ton
8	Goodyear	100 pounds of SO_2 per 1000 pounds of input

All other sources ranging in size from 10-300 $\frac{\text{MMBTU}}{\text{hour}}$ are controlled by

$$E_L = 17.55Q^{-0.3993}$$

and

$$E_L = 1.8\ \frac{\text{pounds } SO_2}{\text{MMBTU}}$$ for sources greater than 300 $\frac{\text{MMBTU}}{\text{hour}}$

*This facility has ceased operation as of January 1976.

Table IV. A. 3-3 RAM
Critical Day Summary-Akron
24-hour Concentrations

Day #	Total Concentration (ug/m^3)	Sources Contributing RAM #	%	Receptor Location (UTM's) X	Y	Required Reduction %
270	1168	1	27	448.1,	4540.2	70
		2	22			
		3	50			
270	902	4,5	54	459.89,	4545.8	62
		6	19			
		7	23			
270	603	10	20	455.71,	4545.32	61
		11	20			
		13	25			
270	1053	32	27	448.05,	4541.05	66
		33	21			
		3	28			
		1	13			
		2	10			
25	1062	43	24	453.02,	4570.98	66
		44	24			
		45	52			
53	622	37, 38	14	459.82,	4543.28	58
		4, 5, 6, 7	25			
		15	22			
		1, 2, 3	11			

capacity of the facilities. Source number 13 has been identified as requiring a reduction in emissions to a level of 1.9 pounds of sulfur dioxide per million BTU heat input. Sources numbers 12 and 14 follow the general regulation for boilers of their size.

The three public comments submitted by B.F. Goodrich contained very little useful information to correct or make more accurate the data used by USEPA. In fact, B.F. Goodrich suggested that more accurate assessment of emission rates is necessary to account for the diurnal variations in emissions from a facility. Dispite their suggestion, B.F. Goodrich did not provide data in this regard.

Similarly, regarding their comment concerning the variability of the half-life of sulfur dioxide in the atmosphere, they did not provide any detailed back-up data to justify their request for a smaller half-life. The value used by USEPA is based on emperical data representative of average conditions.

An additional concern of B.F. Goodrich related to the meteorological data set used in the dispersion model. In both the annual and the short-term modelling, the meteorological data set used for both the upper and lower air represent actual Akron data.

Finnally, source number 13 at the B. F. Goodrich facility identified as significant contributor to a specified receptor. The reduction required by this source to meet the standard is 61% and places an emission limitation on this source of 1.9 pounds of sulfur dioxide per million BTU. All other sources in this facility are regulated by the general fuel combustion regulation.

Source Discussion:

Estimated emission rates for this facility used in the CDM analysis are identical to those values used in the original proposed regulation. The source did not supply any additional information for the base year 1973. Source number 23 is identified as the cement plant. This facility was closed during the beginnning of 1973 in order to effect an adequate calibration. No reduction in emission are required because this source does not have a major impact on receptors in its vicinity and there were no receptors in the vicinity of this source which exceeded the 24-hour standard.

The emission rates utilized in the RAM input were based on the rated capacity of the boilers. The original "first run" emission limitations for this facility was set at 2.1 pounds per million BTU. When this value was tested in the first strategy test, excursions of the standard still occured but at a lesser magnitude. The final value established for each source in this facility is 1.8 pounds of sulfur dioxide per million BTU's.

Source Discussion: B.F. Goodyear

Estimated emission rates for this facility used in the CDM analysis are the same as those used in the original technical support document of September 1975. The information supplied in the public comment could not be used to verify the 1973 base year emissions but was useful in comparing annual fuel consumption values. Source number eight (8) was described by Akron RAPCA as a sulfur recovery unit with an efficiency of conversion of 95% in 1973 (upgraded to 98% in 1975). The emission rate for this source is similar for both RAM and CDM becaue of the lack of data indicating any difference. In spite of the same Q's for the annual and the short-term model, the source in both cases is not a significant contributor to the total predicted. It was later determined that the recent improvement in conversion efficiency of the unit has lowered the orignal SO_2 emission rate. The new emission level is approximately 100 tons of SO_2 per year. The final emission limitation established for this source in this technical support document is 100 pounds of SO_2 per one-thousand pounds of sulfur processed. This value represents the status quo of present emissions from the sulfur recovery unit.

Sources 4,5,6,7, and 15 are combustion sources. The maximum emission rate input for RAM is obtained from design parameters listed in the State information files and/or public comments. Two of the sources CDM/RAM numbers 6 and 7, because of their significant contribution to a predicted excursion of the short-term to a predicted excursion of the short-term standard, required a special emission limitation more stringent than described by the emission limitation expression. This limitation is based on the proportion of reduction required by all sources, in the vicinity of and impacting on a receptor, to bring about attainment of the 24-hour standard. Two other combustion sources, CDM/RAM numbers 4 and 5, are controlled by the genral emission limitation regulation for sources of this size.

Source Discussion: Diamond Crystal

Emission rates used in the CDM analysis are the values used in the original technical support document of September 1975. The reason for this is because the source did not supply any additional data to correct the 1973 base emissions. The emission rates for the RAM analysis are based on the rated capacity of the equipment. Information regarding the rated capacity and the operating parameters of the facilities came from State of Ohio Emission Inventory Confirmation Reports, Point Source Engineering Data Sheets, and the Akron Air Pollution Control Agency.

The existing emission limitation for this facility is 8.1 pounds of sulfur dioxide per million BTU. An examination of this limitation on predicted air quality yielded a reduction of 25% to 6.1 pounds per million BTU to bring predicted levels below the standards.

Source Discussions: Firestone

The comments from Firestone concerning the proposed regulation were not useful in providing additional or new information regarding the operation of their Akron facility. Therefore, the emission rates used for the development of this final regulation were based on the original technical support document. Maximum emission rates for input into RAM were derived from State of Ohio Emission Inventory Confirmation Reports, Point Source Engineering Data Sheets, and public comments submitted by the Akron RAPCA.

Sources 9,10, and 11 are required to control their emissions of sulfur dioxide to 1.5 pounds per million BTU heat input. This level is based on the amount of reduction required by these three sources such that the 24-hour standard will be attained at a number of receptors.

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4. Dayton (Montgomery County)

Montgomery County is located in southwestern Ohio in the Metropolitan Dayton Intrastate AQCR. The population of the region residing in Montogomery County has about half of these people living within the city of Dayton.

Manufacturing in the Region is quite diversified and includes business machines, home appliances, rubber products, and components for automobiles.

Most of the Dayton metropolitan area lies within the Miami River Valley; a nearly flat plain, generally 50 to 200 feet below the elevation of the surrounding countryside. Tributaries, chiefly the Mad River and the Stillwater River, converge on the Miami River at Dayton and extend the river plain to the northwest and northeast. All waterways in the Dayton area drain southward into the Ohio River. The elevation of the Miami river at Dayton is about 750 feet and the surrounding countryside in the form of rolling hills rises to little more than 1,000 feet above sea level.

Precipitation in Montgomery County is rather evenly distributed throughout the year and temperatures are usually moderate.

Temperatures of zero or below will occur four out of every five years, whereas temperatures of 100 degrees or more will occur only one in every five years. Furthermore, extremes in temperature are usually of short duration. Cold, polar air flowing across the Great Lakes causes much cloudiness in the winter and is accompanied by frequent light snow flurries.

The wind is predominantly out of the south-southwest except in February and March, when west-northwest winds prevail. The wind speed averages about eight miles per hour in the summer and about twelve miles per hour in the winter. The Dayton area appears to be much more affected by stagnant air masses extending over large areas of the Midwest than by localized climatological conditions.

The air quality monitoring sites in Montgomery County did record violation of NAAQS in 1973. However more recent data does show that NAAQS is not violated. Local SO_2 regulations and enforcement of them is probably responsible for this improvement. The background SO_2 level was estimated as described in Section II and was found to be $68 \mu g/m^3$. In order to supplement this existing air quality data and to investigate the potential impact of existing sources in Montgomery County, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

Thirty point sources at nineteen seperate facilities were identified in Montgomery County in the Dayton Moetropolitan area. An area source inventory consisting of 79 grids was used in the modelling analyses. Since the air quality data indicates attainment of the annual standards and the nature of the sources indicates that the short term standards would be most critical, only the 3 hr and 24 hr standards were evaluated. For the examination of these short term standards, RAM was utilized with the design emission inventory for the point sources and the area source inventory. The RAM model is described in Section IX; the strategy development methodology is described in Section VIII; and the modelling input parameters as well as the final strategy emission rates are listed in Appendix A.

The full year version of RAM was run with a limited number of receptors to determine the critical days for strategy development. The eight critical days selected for detailed analysis were days 2, 14, 99, 128, 191, 278, 305, and 313. Each of these critical days was run with the significant receptor option of RAM. This option investigates receptors of maximal impact for each source. A summary of the critical results of these runs is listed in Table IV.A.4,-1. A graph of the strategy emission limits in lbs SO_2/MMBTU versus the rated value in MMBTU/hr was plotted and used to develop a strategy regulation. This graph showed that most sources would fit a flat emission limitation with the exception of the facility specific reductions listed in Table IV.A.4-1. A specific limit for the power plant diesel units was also set. It was possible to develop an optional emission limitation for the Hutchings Power Plant because the dispersion analysis indicated no interaction with the other sources in the county.

The initial test strategy was run for the 8 critical days to insure that the standards will be met. Also for the final strategy the 3hr analysis was examined to insure that the secondary standard will also be met. Minor adjustments were made to the test strategy if warrented.

The promulgated strategy for Montgomery County is in paragraph 46 of the regulation.

TABLE IV.A.4-1

Summary of RAM 24 hour
Critical Day Results

DAY	TOTAL X MINUS BACKGROUND	RECEPTOR LOCATION UTM (km)	CONTRIBUTING SOURCES RAM NO.	REDUCTION REQUIRED
99	483	x 740.05 y 4400.94	29-32	25%
99	423	x 744.31 y 4399.77	5,6,29-32	13% for 5,6
99	449*	x 733.37 y 4387.56	25-27	25%
128	363	x 739.18 y 4402.17	1-4,29-32	3% for 1-4

*based on TS1 with input @ 1.60 lbs SO_2/MMBTU

5. Canton (Stark County)

Stark County is located in eastern Ohio in the Metropolitan Cleveland Interstate AQCR.

Canton lies southeast of Cleveland and Akron in generally level terrain. The area is part of an industrial radial extending out of Cleveland. The local industry is steel and petroleum products. The climatology of Canton is typically Ohio in nature. Ohio climate is classified as humid continental, long summer-phase. It is changeable and somewhat unpredictable insofar as local disturbances such as thunderstorms.

The existing air quality monitoring data indicates the attainment of the standards. The existing air quality data was used to estimate the background SO_2 level as described in Section II. This background SO_2 level was set at 29 SO_2/M^3. In order to supplement the existing air quality and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Akron and upper air data from Pittsburgh for the year 1964.

Thirty-nine sources at sixteen facilities were identified in Stark County in the Canton metropolitan area. Since the air quality data indicates attainment of the annual standards and the nature of the source indicates that the short term standards would be most critical, only the 3-hr and 24-hr standards were evaluated. For the examination of these short term standards, RAM was utilized with the design emission inventory. The RAM model is described in Section IX; the strategy development methodology is described in Section VIII; and the modelling imput parameters as well as the final strategy emission rates are listed in Appendix A.

Because of the large number of sources, two full year runs of RAM were done with a common set of receptors. The results of both runs were combined to determine the critical days. The six critical days which were selected for detailed analysis were days 142, 128, 169, 210, 227, and 326. Each of these critical days was run with the significant receptor option of RAM. This option investigates receptors of maximal impact for the top 25 significant sources. A summary of the critical results of these runs is listed in Table IV.A.5-1. The reductions required were applied to the present emission limits. A graph of the strategy emission limits in lbs SO_2/MMBTU versus the rated value in MMBTU/hr was plotted and used to develop a regulation. Outlying emission limits were given facility specific limits.

TABLE IV.A.5-1

Summary of RAM 24 hour Critical Day Results

DAY	TOTAL X MINUS BACKGROUND	RECEPTOR LOCATION UTM (km)	CONTRIBUTING SOURCES SIGN. P RAM No.	%	OTHER SOURCES %	REDUCTION REQUIRED
326	1216	x= 455.00 y=4511.02	16,17	100	0	73%
326	607	x= 472.47 y=4516.66	20-22	95	5	48%
235	354	x= 456.24 y=4514.35	1,3	94	6	6%
326	644	x= 466.84 y=4513.88	10,11,14, 15 35-39	77	23	42%

This initial test strategy was run for the 6 critical days to insure that the standards will be met. The results of these runs showed that a more detailed analysis was required in the Timken-Ashland Oil area. The nature of these sources was such that their contributions became lumped together under "other point sources". The source receptor contribution table showed that all other sources except Timken and Ashland Oil contributed at most 5 $\mu g\ SO_2/m^3$ in the Timken-Ashland region. This value was added to the background and an inventory consisting of only Timken and Ashland Oil sources was used in the test strategy two critical day runs. The strategy for Timken and Ashland Oil was based on these results and used in the test strategy three runs to insure that the standards will be met. Also in the final strategy runs (TS1 and TS3) the 3 hr analysis was examined to insure that the secondary standard will also be met.

The promulgated strategy for Stark County is in paragraph 58 of the regulation.

6. Columbus (Franklin County)

Franklin County is located in Central Ohio and is in the Columbus Intrastate AQCR. The Columbus Region has fewer identification features than most other geographic areas of the state. It is a transitional area between three physiographic sections, and its soil has glacial sandstone and shale in the Eastern half, and glacial limestone deposits in the western half. Manufacturing activities in the region include transportation equipment, appliances, telephone switching equipment, mine machinery, aerospace, control equipment, foundries, metal fabrication, and plastic products.

The geographical features of the Columbus Region range from the Ohio till plain and Central lowland to transition to the Appalachian Plateau. Through the center of the Region runs the Scioto River Valley; the Olentangy River and Big Walnut Creek from the north join the Scioto River in Columbus and south of Columbus, respectively.

Population estimates and trends for the region are discussed in Section VI.

The climatology of Columbus is typically Ohio and typically midwestern in nature. Ohio climate is classified as humid continental, long summer phase. It is changeable and somewhat unpredictable insofar as local disturbance such as thunderstorms. The meteorological conditions of the city itself is interesting insofar as air pollution potential is concerned. Columbus and especially the heavier manufacturing area of town is located in a dish shaped basin in comparison to the rest of the countryside. The result of this feature is a slightly more stable air mass, more persistent morning inversion, and less ventilated area in downtown Columbus.

The existing air quality monitoring data indicates the attainment of the standards. The existing air quality data was used to estimate the background SO_2 level in the county. This determination is discussed in Section II and the background SO_2 level was set at 75 $SO_2/ ^3$. In order to supplement the existing air quality and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

Twenty-six sources at twenty seperate facilities were identified in Franklin County in the Columbus metropolitan area. Since the air quality data indicates attainment of the annual standards and the nature of the sources indicates that the short-term standards would be most critical, only the 3 hr and 24 hr standards were evaluated. For the examination of the short-term standards, RAM was tuilized with the design emission inventory. The RAM model is described in Section IX; the strategy development methodology is described in Section VIII; and the modelling imput parameters as well as the final strategy emission rates are listed in Appendix A.

The full year version of RAM was run with a limited number of receptors to determine the critical days for strategy development. The five critical days selected for detailed analysis were days 23, 312, 265, 73, and 304. A summary of each of these critical days was run with the significant receptor option of RAM. This option investigates receptors of maximal impact for each source. A summary of the critical results of these runs is listed in Table IV.A.6-1. The reductions required were applied to the present emission limits. A graph of the strategy emission limits in SO_2/MMBTU versus the rated value in MMBTU/hr was plotted and used to develop a sliding scale regulation. Outlying emission limits were given facility specific limits.

TABLE IV. A. 6 - 1. Summary of RAM 24 hour Critical Day Results

Day	Total X Minus Background	Receptor Location UTM (km)	Contributing Sources RAM No.	Reduction Required
304	1400	X 337.53 Y 4427.27	24	80%
304	812	X 329.43 Y 4426.45	19	67%
265	654	X 318.57 Y 4425.84	23	59%
23	457	X 328.10 Y 4428.25	24,19,6,4,16,8,7	31%
312	961	X 328.74 Y 4426.68	19,4,16,17,15,8	67%
304	495	X 335.04 Y 4409.08	20	43%
312	505	X 326.35 Y 4426.68	19,6,21,2,1,14,7	31%
304	711	X 328.73 Y 4425.29	19,16,13,17,15	60%
23	594	X 331.31 Y 4429.94	24,19,2,1,8,14,22	43%
73	498	X 319.32 Y 4424.66	23,18	39%
73	599	X 327.49 Y 4426.30	19,4,16,17,15,8,22	48%

This initial test strategy was run for the 5 critical days to insure that the standards will be met. Also for the final strategy the 3 hr analysis was examined to insure that the secondary standard will also be met. Minor adjustments were made to the test strategy if warrented.

The promulgated strategy for Franklin County is in paragraph 27 of the regulation.

7. Cincinnati Metropolitan Area (Modified Rollback)

For the purpose of this study, the Cincinnati urban area shall consist of Hamilton County only.

Sulfur dioxide data from all monitoring locations in the Cincinnati region were examined for this analysis. The 1973 air quality data recorded at 300 Murphy Street in St. Bernard shows that the highest concentrations in the area are:

24 Hour Second Maximum:	99.0 ug/m³
Annual Arithmetic Average:	24.56 ug/m³

Background sulfur dioxide concentrations recorded at the Muddy Creek Pumping Station in Addyston (SAROAD No. 362720003H01) were used in this analysis:

24 Hour Background:	85 ug/m³
Lowest Minimum Annual Average:	13.9 ug/m³

As shown, the National Ambient Air Quality Standards for Cincinnati were being attained in 1973. This can be attributed to a local city regulation restricting all emitters of SO_2 to an emission limitation not to exceed 1.0 lbs. $SO_2/10^6$ BTU heat input and the fact that due to the geographical location of the city, low sulfur coal from Kentucky is readily available.

Emission inventory data obtained from State inventory compilation forms were reduced by source category, and when necessary by process and combustion source categories. There were several exceptions. Miami Fort Power Station, because of its location (distance from the other sources and relatively flat terrain), was handled separately through dispersion modeling procedures, as discussed in Section IV.B.1 of this document. Dupont Fort Hill and Tanner's Creek Power Plant were handled similarly. Boilers for source categories whose future growth rates are zero were combined into one category for calculation purposes. Emissions from Dunbar incinerators, Center Hill incinerators, West Fork incinerators and Reading Municipal Light and Power Company were included in the base year emissions inventory, but were not included in the 1985 projection since they had already ceased operation and are expected to remain permanently shut down.

Growth rates by SIC classification were obtained for Hamilton County, and are summarized in Section VI of this document.

The following emissions resulted from the analysis:

1973:	489.81	grams/second
1985:	538.47	grams/second

After subtracting background and applying this anticipated increase of 9.93 percent in emissions to the remaining anthropogenic concentrations, future background levels were added and the 1985 total sulfur dioxide concentrations were obtained as follows:

24-Hour second Maximum:	100.39 ug/m^3
Annual Arithmetic Average:	25.62 ug/m^3

The concentrations represent a 4.31 percent and 1.4 percent increase in total 24-hour Maximum and Annual Arithmetic Average concentrations respectively, between 1973 and 1985. These results, therefore, indicate that both the existing and projected 1985 ambient sulfur dioxide concentrations are below the 24-hour and annual arithmetic mean National Ambient Air Quality Standards for this pollutant.

Future emissions of sulfur dioxide from facilities in the Cincinnati area are determined as a function of the National Ambient Air Quality Standards and the Prevention of Significant Deterioration Regulations. An analysis was carried out to determine which regulations will represent the limiting case in Cincinnati.

Based on the National Ambient Air Quality Standards (24 hour:365 ug/m^3; Annual:80 ug/m^3) and using the proportional modeling technique, the following minimum increases over the projected 1985 emission levels are calculated:

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Annual Arithmetic Mean:

$$\left(\frac{80-13.9}{25.62-13.9}-1\right) X\ 100 = 4.63\ X\ 100 = 463 \text{ percent}$$

Using the proportional technique and based on the Prevention of Significant Deterioration Regulations the following increases over 1973 levels are calculated if Cincinnati is considered to be a Class II Area and increases of 100 mg/m³ and 15 mg/m³ are allowable for the 24 hour and annual concentrations respectively:

24-hour second high:

$$\left(\frac{(99 + 100)-85}{99-85}-1\right) X\ 100 = 7.14\ X\ 100 = 714 \text{ percent}$$

Annual Arithmetic Mean:

$$\left(\frac{(24.56 + 15)-13.9}{24.56-13.9}-1\right) X\ 100 = 1.41\ X\ 100 = 141 \text{ percent}$$

Based on the results of the annual arithmetic mean calculations, it is concluded that the limiting case is determined under the Prevention of Significant Deterioration Regulations. Accordingly, emission limitations cannot exceed 1180.4 grams/second.

Within this constraint, therefore, an emissions limitation in pounds of sulfur dioxide per million BTU's was determined. This would insure the continued maintenance of sulfur dioxide air quality standards in Hamilton County. The emission limitations are:

a) For catalytic crackers: an emissions limit of 0.2 lbs SO_2 per thousand lbs of charging feed stock;

b) For sulfuric acid plants: 21 lbs SO_2 per ton of 100% acid produced;

c) For fossil fueled-fired steam generating units: the maximum SO_2 emission rate E_{max} is:

E_{max} = 2.0 lbs. $SO_2/10^6$ BTU heat input for all sizes of facilities (design heat input).

With these regulations in effect, future emissions levels of 1067.3 grams of SO_2 per second are projected. This remains below the emissions level of 1146.02 grams of SO_2 per second which provides for the attainment and maintenance of the National Ambient Air Quality Standards as well as the prevention of significant deterioration of air quality in that area. When carrying out these calculations, adjusted base year emissions were determined which account for the strategy regulations. The adjusted base year emissions were subsequently used as the base to which growth data was applied.

8. Steubenville Metropolitan Area (Modified Rollback)

Steubenville is located in the valley region along the Ohio River at the eastern edge of Jefferson County. The Steubenville area, as discussed in this section, will address sources of sulfur dioxide located as far north as Stratton, in Jefferson County, and as far south as Shadyside, in Belmont County. Sources of sulfur dioxide located in West Virginia were not regulated as a result of this strategy development effort.

An examination of all existing air quality data monitored in the region was made and valid information was found to be available in Steubenville and Martins Ferry. For this reason, the study region was subdivided into two separate areas which centered around these two air quality monitors.

An emission inventory was obtained from the North Ohio Valley Air Authority, as presented in Volume II, Appendix A, which summarized sources of sulfur dioxide in both Jefferson and Belmont Counties. With this information, the location of all emission sources was determined with respect to the two monitoring locations.

Steubenville

With respect to the Steubenville monitoring location, a group of sources was situated within approximately five miles of the monitor. Other sources to the north included two small boiler operations in Toronto, Ohio, the Toronto Power Plant in Toronto, and Ohio Edison (Sammis) Power Plant in Stratton. The Toronto and Stratton sources are approximately eight and eleven miles, respectively, from the Steubenville monitor. Approximately eight miles to the south of the monitor are the Cardinal and Tidd Ohio Power electrical generating facilities. Because of the distances of all of these sources from the Steubenville monitor, and because Cardinal, Tidd, and Ohio Edison at Toronto were modelled separately with the MAX T24 Model (as discussed in Section IV of this document), the modified rollback model was used to develop regulations for sources within approximately five miles of the Steubenville monitor.

Because of the distance of the two Toronto boiler operations from Steubenville, and because of their relatively small capacity, it was concluded that they would not contribute significantly to concentrations recorded in Steubenville. For this reason, regulations for these operations are developed for the status quo:

Toronto Paperboard: 5.9 lbs. of SO_2 per million BTU of actual heat input

Kaul Clay: 2.8 lbs. of SO_2 per million BTU of actual heat input

Regulations for the major power generating facilities in Jefferson County are:

Tidd (Ohio Power): 1.6 lbs. SO_2 per million BTU of actual heat input

Cardinal - boilers 1, 2, & 3 (Ohio Power): 4.76 lbs SO_2 per million BTU of actual heat input

The modified rollback model was used to develop regulations for those sources within Steubenville and Mingo Junction. Emission sources in West Virginia, within four to five miles from the monitor in Steubenville, were used in the analysis even though regulations were not developed for them through this analysis. Base year (1974) and future emissions were obtained from the State of West Virginia Air Pollution Control Commission Emission Inventory for sulfur dioxide. Emissions were based on the commission's 1975 SO_2 emission standards. These sources contributed 729.17 grams/second and 494.8 grams/second in 1974 and 1985, respectively.

Emissions were subdivided by individual sources for both boiler and process operations in Steubenville and Mingo Junction. Boiler emissions were further categorized for oil and coal fired operations.

Annual compound growth rates used in the analysis were developed as discussed in Section VI of this document.

The 1974 ambient concentrations of SO_2 used in the analysis were recorded at 814 Adams Street in Steubenville (SAROAD No. 3642012101):

1974 Maximum Annual Arithmetic Average: 107 ug/m^3

1974 24 Hour Second Maximum: 381 ug/m^3

Background SO_2 concentrations used were recorded in Brilliant at 2nd Street (SAROAD No. 363160008102):

1974 Annual Background: 28 ug/m^3

1974 24-Hour Background: 100 ug/m^3

The derivation of this data is further described in Section II.D of this document.

The following emissions resulted from the analysis after application of growth and assuming status quo operating conditions for the sources included in the inventory:

1974: 2103.17 grams/second

1985: 2218.00 grams/second

After subtracting background and applying this anticipated increase of 5.46 percent over eleven years to the remaining anthropogenic concentrations, future background levels were added and 1985 total sulfur dioxide concentrations were obtained:

Annual Arithmatic Average: 111.31

24 Hour Second Maximum: 396.34

Both the 1974 and the projected 1985 concentrations exceed the National Ambient Air Quality Standards. Furthermore, the standards are exceeded for both the 24-hour and annual averages. For this reason, regulations are required which will provide for attainment and maintenance of the ambient air quality standards. Using the proportional modeling technique, the following reductions are necessary to attain the annual standard (80 ug/m^3) AND the 24-hour standard (365 ug/m^3):

Annual Arithmatic Mean:

$$\frac{111.31 - 80}{111.31 - 28} \times 100 = 37.58\%$$

24-hour second high:

$$\frac{396.34 - 365}{396.34 - 100} \times 100 = 10.57\%$$

Based on these results, it is concluded that the limiting case is determined by the annual standards, and an overall reduction of 37.58% from 1985 emission levels will provide for the attainment and maintenance of the standards.

Emission sources of SO_2 in the Cities of Steubenville and Martins Ferry are regulated with the following emissions limits:

Process Operations: 50 grains per 100 standard cubic feet, Oil fired Boilers: 0.8 lbs. SO_2 per million BTU, Coal fired Boilers: 1.8 lbs. SO_2 per million BTU

With these regulations in effect, an emissions reduction of 38.24% from future projected emissions levels will result, and the annual average National Ambient Air Quality Standards will be attained and maintained.

Martins Ferry

With respect to the Martins Ferry monitoring location two sources in Ohio are situated within approximately five to six miles. One of these sources, Wheeling Pittsburg Steel in Yorksville, is actually located in Jefferson County. However, because of its relatively great distance from the Steubenville monitor and its relatively close proximity to the Martins Ferry monitor, it is included in the modified rollback analysis for Martins Ferry. Other sources in the area include several located in West Virginia and one other in Belmont Country, the Ohio Edison R.E. Burger Plant, approximately 12 miles to the south. West Virginia sources within four to five miles of the monitor were considered in the analysis, but were not regulated as a result of this strategy development effort.

Because of the distance of the Ohio Edison Plant from the Martins Ferry monitor, it was concluded that it would not cause significant contributions to concentrations recorded there. Furthermore, this source was modeled seprately with the MAX T24 model as discussed in Section IV.B.1 of this document.

The modified rollback model was used to test regulations for those sources located near the Martins Ferry air quality monitor. Emissions sources in West Virginia within four to five miles from the monitor were used in the analysis. Base year (1974) and future (1985) emissions were obtained from the State of West Virginia Air Pollution Control Commission Emission Inventory for sulfur dioxide. Emissions were based on the Commission's 1975 SO_2 emissions standards. These sources contributed 36.7 grams per second in 1974 and 13.5 grams per second in 1985.

Annual compound growth rates used in the analysis were developed as discussed in Section VI of this document.

Air quality data for Martins Ferry used in this analysis is discussed in Section II of this document. The 1974 maximum annual arithmatic average and the second maximum 24-hour average were used in conjunction with annual and 24-hour background values. This data is presented below:

Maximum annual mean: 65 ug/m^3

Background annual mean: 28ug/^{3}

Highest 2nd max. 24-hour: 169 ug/m^3

Background 24-hour max: 80 ug/m^3

As can be seen, both the annual and 24-hour averages show attainment with the national standards in 1974.

The following emissions resulted from the analysis after application of growth factors and assuming that status quo operating conditions were effective in Ohio.

1974: 458.8 grams/second

1985: 556.32 grams/second

Background levels were subtracted from the maximum annual and 24-hour concentrations, and this anticipated increase in emissions of 21.25 percent over eleven years was applied to the remaining anthropogenic concentrations in order to obtain future anthropogenic concentrations. Future background levels were then added and 1985 total sulfur dioxide concentrations were obtained.

Annual Arithmatic Mean: 72.8 ug/m^3

24-Hour 2nd Max: 187.9 ug/m^3

As shown, both the 1985 annual, and 24-hour averages show attainment with the national standards in 1974. In order to provide for compliance, the following emissions regulations are developed to insure attainment in 1985:

Wheeling Pittsburg Steel-Yorkville: 4.2 lbs. SO_2 per million BTU of actual heat input

Wheeling Pittsburg Steel-Martins Ferry: 2.6 lbs. SO_2 per million BTU of actual heat input.

9. Youngstown Metropolitan Area (Modified Rollback)

This subsection addresses the methodologies and procedures used to develop regulations for the Youngstown Area. The Youngstown Area, as generally discussed in this subsection includes the urban areas of Youngstown and Warren as well as the area enclosed by several outlying emission sources of sulfur dioxide. As discussed below, this area will be subdivided into two subareas, Youngstown and Warren.

An examination of all existing air quality data monitored in the region was made, and valid information was found to be available at three sites in Youngstown and two sites in Warren. For this reason, the study region was subdivided into two separate areas which centered around these two air quality monitors. This would provide the most accurate method of modelling the impacts of the emission sources in an effort to develop regulations.

An emission inventory (base year 1974) was obtained from the Ohio Environmental Protection Agency, as presented in Appendix A, which summarizes sources of sulfur dioxide in both Mahoning and Trumbull Counties in the Youngstown area. With this information, the location of all emission sources was determined with respect to the air quality monitoring locations. Updates of this emission inventory were obtained from the Ohio EPA as recently as August 1976.

Youngstown

With respect to the Youngstown monitoring locations, most sources were located in the proximity of one of the three air quality monitors. Other sources included Canfield Gardens, Whiteacre-Greer Fireproofing, and Lonardo and Sons Greenhouse. Regulations for Whiteacre-Greer Fireproofing were developed for status quo operations due to their very great distance to the Youngstown monitors. The impact of this facility on concentrations monitored in Youngstown would not be significant.

The modified rollback model was used to develop regulations for those sources within five miles of the monitors registering violations of the national standards. An attempt was made to apply the Climatological Dispersion Model (CDM) to Youngstown for rulemaking purposes, however an acceptable calibration of the CDM program could not be achieved.

The emissions inventory obtained from the Ohio Environmental Protection Agency was used to categorize emissions by source. A further subdivision was made by source category for emissions from boilers, and processes and coke oven gas operations.

Annual compound growth rates used in the analysis were developed as discussed in Section VI of this document.

The 1974 ambient concentrations of SO_2 in the Youngstown urban area were recorded at (1) Campbell site 001 (City Hall), (2) Youngstown site 006 (Superior Oakland) and (3) Youngstown site 007 (Central Square):

	1974 Annual Average	1974 2nd Max 24-Hr.
Campbell 001	122.3	333
Youngstown 006	124.9	359
Youngstown 007	88.3	321

For the purposes of this analysis, annual and 24-hour concentrations of 124.9 ug/m³ and 359 mg/m³ were used respectively. Background concentrations of SO_2 employed in the analysis were 28 ug/m³ and 141 ug/m³ for the annual and 24-hour monitoring periods respectively. Derivation of these background and ambient concentrations are elaborated upon further in Section II of this document.

The following emissions resulted from the analysis after application of growth and assuming status quo operating conditions for the sources included in the inventory.

1974: 1276.6 grams/second

1985: 1394.4 grams/second

Background levels were subtracted from the maximum annual and 24-hour concentrations, and this anticipated increase in emissions of 9.23 percent through the projection year was applied to the remaining anthropogenic concentrations in order to obtain future anthropogenic concentrations. Future background levels were then added and 1985 total sulfur dioxide concentrations were obtained:

Annual Arithmatic Mean: 133.95

24-Hour 2nd Maximum: 379.11

Both the 1974 and the projected 1985 concentrations exceed the National Ambient Air Quality Standards. Furthermore, the standards are exceeded for both the 24-hour and annual averages. For this reason, regulations are required which will provide for attainment and maintenance of the standards. Using the proportional technique, the following reductions are necessary to attain the annual standard (80 ug/m^3) and the 24-hour standard (365 ug/m^3):

Annual Arithmatic Mean:

$$\frac{133.95 - 80}{133.95 - 28} \times 100 = 50.9\%$$

24-hour second high: $$\frac{379.1 - 365}{379.1 - 141} \times 100 = 5.9\%$$

Based on these results, it is concluded that the limiting case is determined under the annual standards, and an overall reduction of 50.9% from 1985 emissions levels will provide for attainment of the standards. It should be noted that since the maximum reduction is required in order to attain the annual standard, the development of source category regulations uniformly within the area of study is reasonable since all sources are relatively close to the two minitors with equivalent violations of the annual standard.

The following regulations were found to provide for the attainment and maintenance of the national standards in Youngstown:

Boiler Operations: 0.50 lbs. SO_2 per million BTU

Process Operations: 1.00 lbs. SO_2/Ton

Coke Oven Gas Batteries: 100 grains H_2S per 100 dry standard cubic feet

Plant Specific Regulations:

A. Ohio Edison (N. Ave. Plant) - 2.0 lbs. SO_2 per million BTU

B. Lonardo and Sons Greenhourse - 2.0 lbs. SO_2 per million BTU

C. Whiteacre - Greer Fireproofing - 20 lbs. SO_2 per ton

D. U.S. Steel (McDonald Mills) - 0.5 lbs. SO_2 per million BTU

With these regulations in effect, an emissions reduction of 51.74 percent from future emission levels will result, and the annual average as well as the 24-hour National Ambient Air Quality Standard will be attained and maintained.

Warren

With respect to the Warren monitoring locations, most sources are located within five miles of the monitors. The Ohio Edision Power Plant in Niles was analyzed separately with the MAXT24 Model, as discussed in Section IV of this document, and regulations were developed specifically for this operation.

The modified rollback model was used to develop and test regulations for those sources located near the Warren air quality monitors.

Annual compound growth rates used in the analysis were developed as dicussed in Section VI of this document.

Air Quality data for Warren used in this analysis is discussed in Section II of this document. The 1974 maximum annual arithmatic average and the second maximum 24-hour average were used in conjunction with annual and 24-hour background values. This data is presented below.

Maximum annual mean: 69 ug/m^3

Background annual mean: 28 ug/m^3

Highest 2nd Max 24 hour: 198 ug/m^3

Background 24 hour max: 103 ug/m^3

Both the annual and 24-hour averages show attainment with the national standards in 1974.

The following emissions resulted from the analysis after application of growth and assuming status quo operating conditions at the facilities.

Annual arithmatic mean: 71.49 ug/m³

24-hour 2nd Max: 203.77 ug/m³

As shown, both the 1985 annual and 24-hour averages indicate attainment with the national standards in 1974. In order to provide for compliance, the following regulations are developed for the status quo condition, and are adequate in providing for attainment and maintenance of the standards through 1985.

Coal fired Boilers: 3.00 lbs. SO_2 per million BTU

Oil fired Boilers: 1.00 lb. SO_2 per million BTU

Process Operations: 2.00 lbs. SO_2 per million BTU

Plant Specific Regulations:

Republic Steel Boiler (B001): 0.2 lbs. SO_2 per million BTU (status quo)

Republic Steel process (P001): 1.0 lb. SO_2 per million BTU

Republic Steel Coke Oven Gas Battery: 300 grains of of H_2S per 100 dry standard cubic feet.

IV.B. Rural Analysis

1. Power Plant Counties

ADAMS COUNTY

Stuart Power Plant

Dayton Power and Light Company (DP&L))

The Stuart Power Plant of the DP&L is the only signficant source of emissions in Adams County. This county is located in southern Ohio in the Huntington-Ashaland-Portsmouth-Ironton AQCR. The air quality data in the county indicates that the primary standards have been attained. However, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data, as described in Section II, and estimated to be 72 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3-hour and 24-hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for impact for each receptor were obtained from USGS maps. The meteoroglogical data set utilized was the hourly surface measurements from Cincinnati and the upper air data from Dayton for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24-hour concentration from the plant was 299 ug SO_2/m^3 and the similar 3-hour concentration was 1206.1 ug SO_2/m^3. A slight increase in current emission is allowed.

The promulgated strategy for Adams County is in paragraph 11 of the regulations.

ALLEN COUNTY

Woodcock Power Plant (OE)

The Woodcock Power Plant of the Ohio Power Company is a large single source of emissions in Allen County. This county is located in northwestern Ohio in the Northwest Ohio Intrastate AQCR. The air quality data in the county indicates that the primary standards have been attained. However, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 35 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3-hour and 24-hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling impact parameters for design emissions are listed in Appendix A. The meteorological data set utilized was the hourly surface measure from Dayton and the upper air data from Dayton for the year 1964.

The results of the dispersion modeling anlaysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 94 ug SO_2/m^3 and the similar 3 hour concentration was 159 ug SO_2/m^3. A limited increase in current emission is allowed.

The analysis of other industrial facilities in Allen County is described in Section IV.B. The promulgated strategy for Allen County is in paragraph 12 of the regulations.

ASHTABULA COUNTY

ASHTABULA POWER PLANT (CEI)

The Ashtabula Power Plant of the Cleveland Electric Illuminating Company is the most significant source of emissions in Ashtabula County. This county is located in northeast Ohio in the Northwest Pennsylvania - Youngstown Interstate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was evaluated from existing data as described in Section II and was estimated to be 50 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hr and 24 hr standard, dispersion modelling was utilized.

The Ashtabula facility is located near an industrial park and therefore the interaction between these sources was evaluated using the SCIM dispersion model. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modelling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Erie and the upper air data from Buffalo for the year 1964.

The results of this dispersion modelling analysis which are listed in Appendix A show that the standards are attained. The strategy developed allows increases which are consistent with maintenance of the standards and the prevention of significant deterioration of the present air quality.

The promulgated stategy for Ashtabula County is in paragraph 13 of the regulation.

ATHENS COUNTY:

Poston Power Plant (CSO)

The Poston Power Plant of the Columbus and Southern Ohio Electric Company is the largest single source of emissions in Athens County. This county is located in southern Ohio in the Parkersburg-Marietta Interstate AQCR. The air quality data in the county indicates that that primary standards have been attained. However, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 31 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling imput parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained for USGS maps. The meteorological data set utilized was the hourly surface measurements form Huntington and the upper air data from Huntington for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 420 ug SO_2/m^3 and the similar 3 hour concentration was 1611.4 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 20% from present levels is necessary.

The analysis of other industrial facilities in Athens County is described in Section IV.B. The promuglated strategy for Athens County is in paragrpah 14 of the regulation.

BELMONT COUNTY

Burger Power Plant (OE)

The Burger Power Plant of the Ohio Edison Compnay is the largest single source of emissions in Belmont County. This county is located in eastern Ohio in the Steubenville-Weirton-Wheeling Interstate AQCR. The air quality data in the county indicates that the primary standards have not been attained. In addition, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 84 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 progrm. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Pittsburgh and the upper air data from Pittsburgh for the year 1964.

The results of the despersion modeling analysis are given in

Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 150.7 ug SO_2/m^3 and the similar 3 hour concentration was 427.2 ug SO_2/m^3. Based on a single emission limit for all stacks, a small increase from present levels is allowable. The possible interaction between this source and the Kammer and Mitchell Power Plants is the subject of further study.

The analysis of other industrial facilities in Belmont County is described in Section IV.A.8.

The promuglated stategy for Belmont County is in paragraph 16 of the regulation.

CLARK COUNTY

Mad River Power Plant (OE)

The Mad River Power Plant of the Ohio Edison Company is the largest single source of emissions in Clark County. This county is located in southeastern Ohio in the Dayton Intrastate AQCR. The air quality data in the county indicates that the primary standards have been attained. However, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 64 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilzied.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Dayton and the upper air data from Dayton for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the complaince options equations described in Section VIII. The most critical 24 hour concentration from the plant was 339.4 ug SO_2/m^3 and the similar 3 hour concentation was 641.3 ug SO_2m^3. Based on a single emission limit for all stacks a small increase from present levels is allowable.

The analysis of other industrial facilities in Clark County is described in Section IV.B.

The promugated strategy for Clark County is in paragraph 18 of the regulation.

CLERMONT COUNTY

Beckjord Power Plant (CG&E)

The Beckjord Power Plant of the Cincinnati Gas and Electric Compnay is the only source of emission in Clermont County. This county is located in southwestern Ohio in the Metropolitan Cincinnati Intrastate AQCR. The air quality data in the county indicates that the primary standards have been attained. However, the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 50 ug SO_2/m^3. In order to supplement this existing data and to investigated the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Cincinnati and the upper air data from Dayton for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are the individual stack contribution to all the critical receptors which were needed to develop the complaince option equations described in Section VIII. The most critical 24 hour concentration from the plant was 930.4 ug SO_2/m^3 and the similar 3 hour concentration was 3284.1 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 66% from present levels is necessary.

The promuglated stategy for Clermont County is in paragraph 19 of the regulation.

COSHOCTON COUNTY

Conesville Power Plant (C&SO)

The Conesville Power Plant of the Columbus and Southern Ohio Electric Company is the only source of emissions in Coshocton County. This county is located in central Ohio in the Zanesville-Cambridge Intrastate AQCR. The air quality data in the county indicates that the primary standards have been attained. However the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in

Section II and was estimated to be 63 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilied the MAXT24 program. This program is described in Section IX and the strategy methedology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Columbus and the upper air data from Dayton for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are individual stack contributions to all the critical receptors which were needed to develop the complance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 405.6 ug SO_2/m^3 and the similar 3 hour concentration was 2316.4 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 54% from present levels is necessary.

The promuglated strategy for Coshocton County is in paragraph 21 of the regulation.

GALLIA COUNTY

Gavin Power Plant

Kyger Creek Power Plant (OVEC)

The Gavin Power Plant of the Ohio Power Company and the Kyger Creek Power Plant of the Ohio Valley Electric Company are the significant sources of emissions in Gallia County. This county is located in southern Ohio in the Huntington-Ashland-Portsmouth-Ironton Interstate AQCR. The air quality data in the county indicates that the primary standards have been attained. However, the available data may not reflect the potential impact of these power plants. The background SO_2 level was evaluated from existing data as discribed in Section II and was estimated to be 40 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of these power plants on both the 24 hr standard, dispersion modelling was utilized.

The individual impact of each plant was analyzed with the MAXT24 model and the interaction between the facilities utilized SCIM. These programs are described in Section IX and the strategy methodology is detailed in Section VIII. The modelling input parameters for design emissions are listed in Appendix A. Terrain elevators also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Huntington and the upper air data from Huntington for the year 1964.

The results of the individual impacts for each of these plants are listed in Appendix A. The second maximum 24 hr concentration for the Kyger Creek plant was 221 ug SO_2/m^3 and the second maximum 24 hr concentration for the Gavin facility was 97 ug SO_2/m^3. The results of the SCIM analysis also had to the same conclusion that the primary standard has been attained and that a slight increase in emissions would still maintain the primary standard.

The secondary 3 hr standard of the interaction between these two facilities is the subject of additional investigation. Initial results indicate a second maximum 3 hr value of 174 ug SO_2/m^3. Any contribution of the Gavin facility to this receptor would further aggravate this violation.

The promulgated strategy to attain and maintain the primary standard is in paragraph 28 of the regulation.

HAMILTON COUNTY

Miami Fort Power Plant (CG&E)

The Miami Fort Power Plant of the Cincinnati Gas and Electric Company is the most significant source in Hamilton County. This county is located in the southwest corner of Ohio in the Metropolitan Cincinnati Interstate AQCR. The air quality data which exists in the county indicates that the primary standards have been attained. However the available data may not reflect the maximal impact in the area of this source. The background sulfur dioxide level for the area was evaluated from the existing data as discribed in Section II and was determined to be 53 ug SO_2/m^3 in order to supplement this existing data and to investigate the potential impact of this power plant on the short term standards, dispersion modelling was utilized.

The Miami Fort Power Plant is not an isolated facility. The Dupont sulfuric acid plant and the Tanners Creek Power Plant of the Indiana and Michigan Electric Company located in Indiana are situated sufficiently near the Miami Fort facility for interaction to occur. The MAXT24 program was utilized to investigate the individual impact of each facility and SCIM was used to evaluate the interaction between these sources. Both of these dispersion models are described in Section IX. The strategy development methodology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. The Tanners Creek emissions assumed final compliance with the current approved state implementation plan (SIP). Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Cincinnati and the upper air data from Dayton for the year 1964.

The results of the MAXT24 analysis for the Miami Fort Plant were 322 ug SO_2/m^3 for the second maximum 24 hr concentration and 1285 ug SO_2/m^3 for the second maximum 3 hr concentration. These results and the background level require a 3% reduction in emmissions from this facility without considering any interaction.

The results of the MAXT24 analysis for the Dupont Plant were 362 ug SO_2/m^3 for the second maximum 24 hr concentration and 1359 ug SO_2/m^3 for the second maximum 3 hr concentration. These results and the background level require a 22% reduction in emissions without considering any interaction.

The results of the SCIM analysis shows that at the critical receptor the 24 hr concentration was 500.4 ug SO_2/m^3. Using the background level and the contribution 36.2 ug SO_2/m^3 for the Indiana source, requires a total reduction of 41% for the Ohio sources. The point source contribution table for this critical receptor shows that stacks 3 and 4 contribute 87% of the total centration. The strategy selected requires a 22% reduction for DuPont as determined by the individual analysis, the status quo for stacks 2 and 5, and the remaining reductions from stacks 3 and 4. (Stack 6 is subject to NSPS). This required an average reduction of 40.5% for these two stacks. No optional compliance equations could be developed becuase of the interaction between all these sources.

The remaining industrial sources in Hamilton county are discussed in Section IV.A.7.

The promulgated strategy for Hamilton County is in paragraph 30 of the regulation

JEFFERSON COUNTY

Cardinal Power Plant (OP)
Tidd Power Plant (OP)
Sammis Power Plant (OE)
Toronto Power Plant (OE)

There are four major power plants in Jefferson County in the Ohio River valley. These are the Cardinal Power Plant, the Tidd Power Plant, both operated by the Ohio Power Company, the Sammis Power Plant, and the Toronto Power Plant, the latter two owned by the Ohio Edison Company.

Jefferson County is located in eastern Ohio in the Steubenville-Weirton-Wheeling AQCR. The air quality data in the county indicates non-attainment of the standards. However this available data may not reflect maximal impact of these power plants. Background sulfur dioxide levels were evaluated for each power plant from existing data as described in Section II. The short term background level for the Tidd facility was determined to be 100 ug SO_2/m^3 and the background level for the other three facilities was determined to be 84 ug SO_2/m^3.

Each of the facilities was analyzed as an isolated facility to determine its individual impact. The MAXT24 dispersion model used in these analyses is described in Section IX. The strategy development methodology is further detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations at all receptor locations also needed for input were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Pittsburgh and the upper air data from Pittsburgh for the year 1964.

The results of the dispersion modeling analyses are given in Appendix A. Included in these tabulations are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII.

The most critical 24 hour concentraton from the Tidd Power plant was 1100 ug SO_2/m^3 and the similar 3 hour concentration was 4639.8 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 74% from present levels is necessary.

The most critical 24 hour concentration from the Cardinal Power Plant was 246 ug SO_2/m^3 and the similar 3 hour concentration was 1171.2 ug SO_2/m^3. A slight increase in emissions is allowed.

Since the Cardinal and Tidd facilities are relatively near each other, an interaction analysis was also completed. The conclusion of this anslysis was that the individual impacts of the facilities was most critical for strategy development.

The most critical 24 hour concentration from the Sammis Power plant was 561.1 ug SO_2/m^3 and the similar 3 hour concentration was 1858.2 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 42% from present levels is necessary.

The most critical 24 hour concentration from the Toronto Power Plant was 227.9 ug SO_2/m^3 and the similar 3 hour concentration was 646.9 ug SO_2/m^3 . An increase in emissions from this plant is allowed.

Since the distance between the Sammis and Toronto facilities is not great, the possible interaction between these facilities is the subject of additional investigation.

The analysis of the other industrial facilities located in Jefferson County is discussed in Section IV.A.8.

The promulgated strategy for Jefferson County is in paragraph 34 of the regulations.

MORGAN COUNTY

Muskingum River Power Plant (CSO)

The Muskingum River Power Plant of the Columbus and Southern Ohio Electric Company straddles the Washington-Morgan County line. The complete description of the analysis of this power plant is discussed later in this section under WASHINGTON/MORGAN COUNTIES.

MUSKINGUM COUNTY

Philo Power Plant (OP)

The Philo Power Plant of Ohio Power Company is the largest single source of emissions in Muskingum County. This county is located in east central Ohio in the Zanesville-Cambridge Intrastate AQCR. The air quality data in the county indicates that the primary standards have been attained. However the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 78 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nautre of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methedology is detailed in Section VIII. The modelling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor was obtained from USGS maps. The meteoroglogical data set utilized was the hourly surface measurements from Columbus and the upper air data from Dayton for the year 1964.

The results of the dispersion modelling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance options equations described in Section VIII. The most critical 24 hour concentration from plant ws 1670.1 ug SO_2/m^3 and the similar 3 hour concentration was 4620.3 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 82% from present levels is necessary.

The analysis of other industrial facilities in Muskingum County is described in Section IV.B.

The promulgated strategy for Muskingum County is in paragraph 48 of the regulations.

PICKAWAY COUNTY

Picway Power Plant (CSO)

The Picway Power Plant of the Columbus and Southern Ohio Electric Company in the largest single source of emissions in Pickaway County. The county is located in central Ohio in the Metropolitan Columbus Intrastate AQCR. The air quality data in the county indicates that the primary standards have not been violated since 1973. However, the available data does not reflect the potential impact of the power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 118 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modeling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Sction IX and the strategy methodolology is detailed in Section VIII. The modeling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Columbus and the upper air data from Dayton for the year 1964.

The results of the dispersion modelling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 597.6 ug SO_2/m^3 and the similar 3 hour concentration was 1912 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 49% from present levels is necessary.

The analysis of other industrial facilites in Pickaway County is described in Section IV.B.

The promulgated strategy for Pickaway County is in paragraph 51 of the regulation.

TRUMBULL COUNTY

Niles Power Plant (OE)

The Niles Power Plant of the Ohio Edison Company is the largest single source of emissions in Trumbull County. This county is located in northeastern Ohio in the Northwest Pennsylvania-Youngstown Interstate AQCR. The air quality data in the county indicates that the primary standards have not been attained. In addition the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in Section II and was estimated to be 84 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standards, dispersion modelling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodology is detailed in Section VIII. The modelling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Youngstown and the upper air data from Pittsburgh for the year 1964.

The results of the dispersion modelling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in section VIII. The most critical 24 hour concentration from the plant was 340.2 ug SO_2/m^3 and the similar 3 hour concentration was 877.8 ug SO_2/m^3. Based on a single emission limit for all stacks, a small increase from present levels is allowable.

The analysis of the other industrial facilities in Trumbull County is described in Section IV.A.9.

The promulgated strategy for Trumbull County is in paragraph 60 of the regulation.

WASHINGTON/MORGAN COUNTY

Muskingum River Power Plant (OP)

The Muskingum River Power Plant of the Ohio Power Compnay is the largest single source of emissions in Washington and Morgan Counties. These counties are located in southeast Ohio in the Parkersburg-Marietta Interstate AQCR. The air quality data in the county indicates that the primary standards have been attained. However the available data may not reflect the potential impact of this power plant. The background sulfur dioxide level was evaluated from existing data as described in

Section II and was estimated to be 28 ug SO_2/m^3. In order to supplement this existing data and to investigate the potential impact of this power plant on both the 3 hour and 24 hour standard, dispersion modelling was utilized.

Because of the isolated nature of this facility, the analysis utilized the MAXT24 program. This program is described in Section IX and the strategy methodlogy is detailed in Section VIII. The modelling input parameters for design emissions are listed in Appendix A. Terrain elevations also needed for input for each receptor were obtained from USGS maps. The meteorological data set utilized was the hourly surface measurements from Huntington and the upper air data from Huntington for the year 1964.

The results of the dispersion modeling analysis are given in Appendix A. Included in these results are the individual stack contributions to all the critical receptors which were needed to develop the compliance option equations described in Section VIII. The most critical 24 hour concentration from the plant was 256 ug SO_2/m^3 and the similar 3 hour concentration was 1921 ug SO_2/m^3. Based on a single emission limit for all stacks, a reduction of 33% from present levels is necessary.

The analysis of other industrial facilities in Washington County is described in Section IV.B.

The promulgated strategy for Washington and Morgan Counties is in paragraphs 47 and 63 of the regulation.

2. RURAL ANALYSIS - INDUSTRIAL FACILITIES

A. Allen

Allen County is located in North West Ohio in the Northwest Ohio Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level were extrapolated from available data as described in Section II and was estimated to be 35 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly metorological data from Dayton and upper air data from Dayton for the year 1964.

With the exception of Central Soya, all the identified sources of SO_2 in Allen County are located in the vicinity of the City of Lima. The dispersion analysis used for Central Soya was MAXT24 methodology described in Section IX. The remaining sources because of their geographical proximity to each other were used in the rural version of RAM also described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The dispersion analysis for Central Soya indicated that the second maximum 24 hr. concentration from this plant is 67 ug SO_2/m^3. For this plant, the PSD increment rather than NAAQS was the limiting case for strategy development. The resulting emission limitation was greater than 10.0 lbs SO_2/MMBTU. An emission limitation of this value indicates no potential problem from this source.

The remaining sources were analyzed using the rural version of PAM. This analysis showed that day 99 was critical for strategy development for all the sources. Using the source-receptor contribution tables, NAAQS, and the PSD increment, emission limits were established for Ford Motor Co. Lima State Hospital, Vistron Corporation, Clark Equipment Co. and Standard Oil.

The promulgated strategy for Allen County appears in paragraph 12 of the regulation.

B. Ashtabula County

Ashtabula County is located in Northeast Ohio in the Northwest Pennsylvania-Youngstown Interstate AQCR. The present air quality of the county has not been measured due to the absence of monitoring stations. The background SO_2 level was extrapolated from available date as described in Section II and was estimated to be 50 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Erie and upper air data from Buffalo for the year 1964.

The only source identified in this county were CEI's (Cleveland Electric Illuminating Company's) Ashtabula Power Plant and a group of industrial facilities located 1-2 km away. This entire grouping of sources and consequent strategy development is discussed in Section IV. B. 1.

The promulgated strategy for Ashtabula County is stated in paragraph 13 of the regulation.

C. Athens County

Athens County is located in Southeast Ohio in the Parkersburg-Marietta Interstate AQCR. Air quality monitoring sites in the county indicate attainment of NAAQS. However the data is not conclusive since the sites surrounding the Poston Power Plant do not meet sampling criteria and the other site which is part of the Kyger Creek-Gavin-Sporn network does not reflect the impact of the sources in the County itself. The SO_2 background level was estimated as described in Section II to be 31 ug SO_2/m^3. In order to supplement the limited existing air quality data and to investigate the potential impact of the existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Huntington and upper air data from Huntington for the year 1964.

The largest single source in Athens County is Columbus and Southern Ohio Electric Company's Poston Generating Station. This facility is isolated and its analysis and strategy development is discussed in Section IV. B. I.

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The remaining two identified sources are located in close proximity to each other and their impact was elevated using the SCIM program described in Section IX. The modelling results which were critical for strategy development are listed in Appendix A.

The SCIM analysis showed that July 3 was the critical day for both sources. Using the source-receptor contribution tables and the PSD increment, single emission limitations were established for these sources.

The promulgated strategy for Athens County is in paragraph 14 of the regulations.

D. Auglaize County

Auglaize County is located in Western Ohio Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 45 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

The two sources identified in the county are in close proximity to each other and were analyzed using the SCIM described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The SCIM analysis showed that May 21 was the critical day for both sources. Using the source-receptor contribution tables and the PSD increment, emission limitations were established.

The strategy emission limitation for the St. Mary Power Plant is greater than 10 lbs. SO_2/MMBTU and therefore no potential problem exists from this source. The Goodyear facility uses fuels of several qualities with respect to sulfur dioxide emissions. The strategy was refined to a single emission limitation for this facility.

The promulgated strategy for Auglaize County is in paragraph 15 of the regulation.

E. Butler County

Butler County is located in Southwest Ohio in the Metropolitan Cincinnati Interstate AQCR. The air quality monitoring station in the City of Hamilton indicates that NAAQS has been attained. This monitor is reflective of some of the industrial sources within this county. The background SO_2 level was estimated as described in Section 2 from the available air quality data to be 52 ug SO_2/m^3. In order to augment the existing air quality data and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Cincinnati and upper air data from Dayton for the year 1964.

All the sources identified in the county were in the region of the Cities of Hamilton and Middletown. The geographical proximity of these sources made the rural RAM model described in Section IX the most appropriate to use. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The RAM analysis showed that the critical day varied from source to source, however the three days 2, 50, and 224 comprise the critical days of the majority of the sources. In all cases, the ground level concentrations were significantely below NAAQS and consequently, the PSD increment became the determining factor for strategy development. Using the source-receptor contribution tables appropriate emission limitations were established.

To develop a strategy the rated capacity of each source was plotted as a function of both minimum and maximum limitation. The status quo was the minimum emission limited and the allowed increase above the status quo was the maximum. The single flat rate emission limitation of 1.40 lbs SO_2/MMBTU statisfied the creiteria of both no reductions in emissions from present levels and no increase in emissions for present levels. A parallel procedure was used for those processes which are presently using COG.

The promulgated strategy for Butler County is in paragraph 16 of the regulation.

F. Clark County

Clark County is located in the Southwest Central region of Ohio in the Dayton Intrastate AQCR. The air quality monitoring station in the City of Springfield indicates that NAAQS has been attained. The background SO_2 level was estimated from the available air quality data as described in Section II and was determined to be 64 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impact of the existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

The largest single source in Clark County is Ohio Edison Company's Mad River Generating Station. This facility is isolated and its analysis and strategy development is thoroughly discussed in Section IV. B. I.

The only other identified source in the county is also isolated and its potential impact was evaluated using the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The MAXT24 analysis showed since the strategy emission limit was greater than 10 lbs SO_2/MMBTU, this source presents no potential problem.

The promulgated strategy for Clark County is in paragraph 18 of the regulation.

G. Columbiana County

Columbiana County is located along the eastern border of Ohio in the Steubenville-Wierton-Wheeling Interstate AQCR. The present air auality monitors indicate non-attainment of the annual average SO_2 standard. The location of the monitoring site is in the City of East Liverpool in the Ohio River Valley. The only identified source in this county is in the City of East Palestine which is not in the river valley and is approximately 22 km away. This source does not affect the East Liverpool monitors and the violation of NAAQS is the result of nereby sources located in the river valley situated on the opposite side of the river in West Virginia.

The background SO_2 level was estimated from the limited available air quality data as described in Section II and was determined to be 64 ug SO_2/m^3. In order to supplement the air quality data and to investigate the present and potential impact of the existing source in East Palestine, dispersion modelling analysis was utilized with hourly surface meteorological data from Pittsburg and upper air data from Pittsburg for the year 1964.

The only identified source is isolated and was analyzed using the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The highest second high 24 hour ground level concentration of 362 ug SO_2/m^3 together with the background level requires a 17% reduction in emissions from present levels.

The promulgated strategy for Columbiana County is in paragraph 20 of the regulation.

H. Crawford County

Crawford County is located in northern central Ohio in the Mansfield-Marion Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 20 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

The only identified source in this county was analyzed using the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling result which was critical for strategy development are listed in Appendix A.

The dispersion analysis indicates that the second highest concentration is 11 ug SO_2/m^3. Using this result with the PSD increment the strategy limits the source to 9.6 pounds of sulfur dioxide per million BTU of actual heat input.

The promulgated strategy for Crawford County is in paragraph 22 of the regulation.

I. Delaware County

Delaware County is located in central Ohio in the Metropolitan Columbus Intrastate AQCR. The present air quality of the county cannot be documented with measurements due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 50 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

The only identified source in this county was analyzed using the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling result which was critical for strategy development are listed in Appendix A.

The dispersion analysis indicates that the second highest 24 hr. average concentration was 258 ug SO_2/m^3. Using this result with the background value the strategy limits this source to slightly above the current level in order to continue attainment of the standard.

The promulgated strategy for Delaware County is in paragraph 24 of the regulation.

J. Erie County

Erie County adjoins Lake Erie in Central Ohio in the Sandusky Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 levels were extrapolated from available data as described in Section II and was estimated to be 15 ug SO_2/m^3. In order to investigate the present and potential impact from existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Toledo and upper air data from Flint for the year 1964.

Only two sources were identified in this county. The sources differ in that only steam generators are at one site and the other includes only process operations. Since both sources are isolated, an individual analysis using the MAXT24 program described in Section IX was performed. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The dispersion analysis for the process operations is 58 ug SO_2/m^3. Using this result with the PSD increment the strategy limits the source.

The dispersion analysis indicates that the second highest 24 hr. average concentration from the steam generators is 949 ug SO_2/m^3. Using this result together with the background value, a reduction of 63% from current emission levels is needed to attain the standard.

The promulgated stratedy for Erie County is in paragraph 25 of the regulation.

K. Fairfield County

Fairfield County is located in south central Ohio in the Metropolitan Columbus Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 65 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

Several sources were identified in the county. However, all these sources were geographically isolated from each other and individual analyses using the MAXT24 program were performed. This methodology is described in detail in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The dispersion analysis of the Diamond Power Specialty Company indicates that the second high 24 hr. concentration is 213 ug SO_2/m^3. Using this result and the background level the strategy limits the source.

The dispersion analysis of Crown Zellerbach indicates that the second high 24 hr. concentration is 143 ug SO_2/m^3. Using this result and the PSD increment the strategy limits this source. Crown Zellerbach utilizes coals of substantially different quality with respect to SO_2 emissions. Applying the strategy allowed 70% increase results in a limit less than 10.0 lbs SO_2/MMBTU for only one stack. The other stack poses no potential problem. The stack identification used in the regulation is identical to the stack identification described in the letter of John W. Walz of Crown Zellerbach dated June 27, 1975, to USEPA.

The dispersion analysis of the remaining sources in the county indicate attainment of the standard. The promulgated strategy for Fairfield County is in paragraph 26 of the regulation.

L. Greene County

Greene County is located in southwestern Ohio in the Dayton Intrastate AQCR. The present air quality monitors indicates attainment of the standards. However the location of these sites may not be optimal for the existing point sources in the county. The background SO_2 level was estimated from available data as described in Section II and was determined to be 59 ug SO_2/m^3. In order to supplement the existing air quality and to investigate the potential impact of existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

The analysis of Greene County utilized computer models MAXT24, SCIM, and rural RAM. These models are described in Section IX. Antioch College and Central State University were analyzed with individual MAXT24 runs because of the geographical isolation of these sources. SCIM and MAXT24 were used to analyze the interaction and individual impacts of the process sources in the county. Rural RAM was used to analyze the complex of buildings at the Wright Patterson Air Force Base (WPAFB). The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The MAXT24 dispersion modelling analysis for Antioch College indicates that the second highest concentration is 29 ug SO_2/m^3. Using this result and the PSD increment the strategy limits this source.

The MAXT24 dispersion modelling analysis for Central State University indicates that the second highest concentration is 197 ug SO_2/m^3. Using this result and the PSD increment the strategy limits this source.

The SCIM analysis of the interaction between the processes of the Southwestern Portland Cement Co. and the Universal Atlas Cement Co. indicates that the individual impact of each source is more critical to strategy development than the interation between the facilities. The individual impact of the Universal Atlas Cement Co. the ground level concentration is 242 ug SO_2/m^3. Using this result and the background level the strategy limits the source. Since all these processes are of different capacities and use coals of different sulfur content, a sliding scale was developed which satisfied the strategy emission limitations for all the processes.

The rural RAM analysis for the complex of buildings at the WPAFB shows that critical impacts for the different buildings occurred on days 99, 50, or 86. On day 99 the critical ground level concentration for Building 271 was 970 ug SO_2/m^3. The source-receptor contribution table indicates that this is the only source contributing to this receptor. Using this result and the background level requires a reduction of 69% from current levels for Building 270. Also on day 99 the critical ground level concentration for Building 2 was 1192 ug SO_2/m^3. The source-receptor contribution table indicates that this is the only source contributing to this receptor. Using the result and the background level requires a reduction of 68% from current levels for Building 270. Also on day 99 the critical ground level concentration for Building 66 was 1192 ug SO_2/m^3. The source-receptor contribution table indicates that this is the only source contributing to this receptor. Using this result and the background level requires a reduction of 75% from current levels for Building 66. On day 50 the critical ground level concentration for Building 170 was 358 ug SO_2/m^3. The source-receptor contribution table indicates that this is the only source contributing to this receptor. Using the result and the background level requies a reduction of 15% from current levels for Building 170. Also on day 50 the critical ground level concentration for Building 1240 was 343 ug SO_2/m^3. The source-receptor contribution table indicates that Building 170 and 1240 contribute to this receptor. Applying the previously determined 15% reduction to Building 170's contribution reduces the total ground level concentration to 314 ug SO_2/m^3. Using this result and the background level requires a reduction of 6% from current levels for Building 1240. On day 86 the critical ground level concentration for Building 770 was 497 ug SO_2/m^3. The source-receptor contribution table indicates that Buildings 66 and 770 contribute to this receptor. Applying the previously determined

75% reduction to Building 66's contribution reduces the total ground level concentration to 336 ug SO_2/m^3. Using this result and the background level requires a reduction of 11% from current levels for Building 770.

The promulgated strategy for Greene County is in paragraph 29 of the regulation.

M. Hancock County

Hancock County is located in northwest Ohio in the Northwest Ohio Intrastate AQCR. The present air quality of the county cannot be documented with measurements due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 25 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surfact meteorological data from Toledo and upper air data from Flint, Michigan for the year 1964.

All the identified sources in Hancock County are located as a geographical group. Therefore, the analysis of these sources used was the MAXT24 to evaluate the individual impacts and SCIM to evaluate the interactions. Both these programs are described in Section IX. The modelling input parameters as well as the modelling results which were most critical for strategy development are listed in Appendix A. It should also be noted that the only sulfur dioxide emissions from the Ashland Oil

Refinery are from fuel combustion sources (i.e. direct and indirect heat exchangers) and not from any process.

The dispersion modelling analysis using SCIM indicates that the impact of each individual source is more critical to strategy development than is any interaction between the sources. The results of the individual sources' impact and the PSD increment limit the source. The strategy selected is greater than the existing level but does not exceed the minimum emission limit after applying the strategy increase to the status quo emission levels.

The promulgated strategy for Hancock County is in paragraph 31 of the regulation.

N. Henry County

Henry County is located in northwestern Ohio in the Northwest Ohio Intrastate AQCR. The present air quality in the county cannot be documented with measurements due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 15 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surfact meteorological data from Toledo and upper air data from Flint, Michigan for the year 1964.

The two identified sources in Henry County are both located in the City of Napoleon. In a letter datea August 14, 1975, from M.R. Dorsey of the City of Napoleon to USEPA, the City's power plant will cease operations in September, 1975. Therefore the single remaining source is isolated and was analyzed using the MAXT24 program described in Section IX. The modelling input prameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion modelling analysis indicated that the second maximum 24 hr. concentration from this plant is 83 ug SO_2/m^3. Using the result and the PSD increment, the strategy limits this source. The plant uses both coal and oil in its boilers. The resulting emission limits after applying the strategy increase uniformly to both fuel types, shows that only an emission limitation for oil is warranted. The emission limitation of greater than 10.0 lbs SO_2/MMBTU was resulted for the coal fired units indicates no potential problem from these sources.

The promulgated strategy for Henry County is in paragraph 32 of the regulation.

O. Huron County

Huron County is in north central Ohio in the Sandusky Intrastate AQCR. The present air quality of the county cannot be documented with measurements due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be

20 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly meteorological data from Toledo and upper air data from Flint, Michigan for the year 1964.

The only identified source in Huron County was analyzed using the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion modelling analysis indicates that the second maximum 24 hr. concentration is 262 ug SO_2/m^3. Using this result and the background level, the strategy limits the source to 8.0 pounds of sulfur dioxide per million BTU of actual heat input.

The promulgated strategy is in paragraph 33 of the regulation.

P. Lawrence County

Lawrence County is located at the southern most tip of Ohio in the Huntington-Ashland-Portsmouth-Ironton Interstate AQCR. The present air quality monitoring data in Lawrence County indicates atainment of NAAQS. However, the location of this site was not designed to reflect the maximul impact of the existing sources. The background SO_2 level was determined from the available data as described in Section II and was determined to be 47 ug SO_2/m^3. In order to supplement the limited available air quality data and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Huntington and upper air data from Huntington for the year 1964.

With the exception of the Marquette Cement Company, all the other identified sources are located in close proximity of one another. The dispersion analysis used for Marquette Cement was the MAXT24 because of its isolated location. The remaining sources because of their geographical proximity to one another were analyzed using the rural version of RAM. Both of these models are described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed in Appendix A.

The dispersion analysis of the Marquette Cement Company indicates that the second maximum 24 hr. ground level concentration is 14 ug SO_2/m^3. Using this result and the PSD increment, the strategy limits the source.

The results of RAM analysis indicates that day 10 is the critical day for all the remaining sources. However, the locations and impacts differ for the various sources. The source-receptor contribution table was used to determine the strategy. At the critical receptor for the Allied Chemical Co., Specialty Chemical Division, the ground level concentration of 229 ug SO_2/m^3, none of the other sources contributed to the total. Using this result together and the background level, the strategy establishes an emission limitation for the Specialty Chemical Plant. Similarly North American Refractories is the only contributor to a receptor value of 170 ug SO_2/m^3. Using this result and the PSD increment, strategy limits this source. The remaining sources interact at another receptor totaling 107 ug SO_2/m^3. Using this result and the PSD increment, the strategy limits the remaining sources. The final strategy is an emission limit which is above the present level but does not exceed the minimum value after applying the strategy increases to all the sources. Sources whose emission limits differed noteably from this strategy approach were specifically identified.

The promulgated strategy for Lawrence County is in paragraph 36 of the regulation.

Q. Licking County

Licking County is located in central Ohio in the Metropolitan Columbus Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 65 ug SO_2/m^3. In order to investigate the present and potential impact from existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

All the identified sources in Licking County are geographically seperated from each other. Due to the isolated nature of the sources, the MAXT24 program was used in an individual analysis for each source. This program is described in detail in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are located in Appendix A.

The results of the dispersion modelling analysis indicates that the second maximum 24 hr. concentrations are below the standard. Therefore for these sources no potential problems exists. For those sources burning oil. an upper limit was necessary

The promulgated strategy for Licking County is in paragraph 37 of the regulation.

R. Marion County

Marion County is located in central Ohio in the Mansfield-Marion Intrastate AQCR. The present air quality in the county cannot be documented due to the lack of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 35 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

All the identified sources in Marion County are located in close proximity to each other. Therefore the analysis of these sources was done using the rural version of RAM. This model is described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion modelling analysis shows that the interaction between the seperate sources is minimal and that a single source dominates each critical receptor. The source-receptor contribution table for day 118 was sufficient for strategy development. The critical receptor for Huber Corp. indicates that the ground level concentration is 358 ug SO_2/m^3. Using this result and the background value requires a reduction of 8% from current emission levels for this source. The critical receptors for the remaining sources have ground level concentrations ranging from 64 to 202 ug SO_2/m^3. Using the individual results and the PSD increments, the strategy allows limited increases above current emission levels.

The promulgated strategy for Marion County is in paragraph 41 of the regulation.

S. Medina County

Medina County is located in northern Ohio in the Greater Metropolitan Cleveland Intrastate AQCR. The only air quality monitoring site in the county had not recorded sufficient information to draw any statistically significent conclusion concerning the present air quality in the county. The background SO_2 level in the county was estimated from the limited air quality data available as described in Section II and was determined to be 21 ug SO_2/m^3. In order to supplement this limited air quality data and to investigate the potential impact from the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Akron and upper air data from Pittsburgh for the year 1964.

Both of the sources identified in Medina County are isolated from each other. Therefore the MAXT24 program was utilized in an individual analysis for each source. This program is described in detail in Section IX. The modelling imput parameters as well as the modelling results which were critical to the strategy development are listed in Appendix A.

The dispersion modelling shows that the second maximum 24 hr. concentration for each source was below the standard. Using the individual results and the PSD increments, the strategy allows increases from current emission levels. The final strategy is the minimum emission limits after applying the applicable strategy increases to both sources.

The promulgated strategy for Medina County is in paragraph 42 of the regulation.

T. Meigs County

Meigs County is located in southeastern Ohio in the Parkersburg-Mariette Interstate AQCR. The only air quality monitoring site in the county indicates that the standards are being met. However, this site is part of a power plant network and may not be reflective of the impact of the existing source in the county. The background SO_2 level was estimated from the available data as described in Section II and was estimated to be 35 ug SO_2/m^3.

Only one source is identifiable in Meigs County. The proposal described this source as a fuel combustion source. The review of the data base identifies this source to be a process. The reveiw of the public comments did not present any reasons to change the strategy. The promulgated strategy is a process regulation which is equivalent to the proposal.

The promulgated strategy for Meigs County is in paragraph 43 of the regulation.

U. Mercer County

Mercer County is located on the western border of Ohio in the Northwest Ohio Intrastate AQCR. The present air quality of the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 50 ug SO_2/m^3. In order to investigate the present and potential impact from the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

The only identified source in Mercer County is isolated and was analyzed using the MAXT24 program. This program is described in Section IX. The modelling imput parameters as well as the modelling results which were most critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis indicates that the second maximum 24 hr. concentration was 14 ug SO_2/m^3. Using this result and the PSD increment, the strategy establishes an emission levels.

The promulgated strategy is in paragraph 44 of the regulation.

V. Miami County

Miami County is located in southwestern Ohio in the Dayton Intrastate AQCR. The air quality data indicates that the standards have been attained in the County. However the siting of the monitors may not show the maximal impact of the sources. The background SO_2 level were estimated from the available data as described in Section II and was determined to be 66 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data for Dayton for the year 1964.

All the identified sources in Miami County are geographically separated from each other. Because of this isolation, the MAXT24 program was utilized in an individual analysis for each source. This program is described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The largest single source in the county is the City of Pequa Municipal Power Plant. The analysis and strategy development of this source is described in Section IV. B. I.

The dispersion modelling analysis of the other fuel combustion sources indicates attainment of the standards. Using the individual results and the PSD increments, the strategy allows increases from present levels. The strategy is above current levels but establishes an upper limit after application of respective increases to the status quo.

Similarly the second maximum impact of the process source was used with the PSD increment to limit this source.

The promulgated strategy is in paragraph 45 of the regulation.

W. Muskingum County

Muskingum County is located in central Ohio in the Zanesville-Cambridge Intrastate AQCR. The existing air quality monitoring stations indicate that the standards have been attained. However since these sites are part of the power plant's network this data may not be reflective of the other sources in the county. The background SO_2 level was determined from the available data as described in Section II and was estimated to be 78 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impact from existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

All the identified sources in Muskingum County are geographically isolated from each other. Therefore the MAXI24 program was utilized in an individual analysis for each source in the county. The modelling imput parameters as well as the modelling results which were most critical for strategy development are listed in Appendix A.

The largest single source in the county is the Ohio Power Company's Philo Generating Station. The analysis and strategy development of this source is described in Section IV. B. I.

The dispersion modelling analysis of the remaining fuel combustion source indicated that the second maximum 24 hr. concentration is 29 ug SO_2/m^3. Using this result and the PSD increment, the strategy allows limited increase above present levels.

The dispersion modelling analysis of the process source indicated that the second maximum 24 hr. concentration is 15 ug SO_2/m^3. Using this result and the PSD increment, the strategy allows a limited increase above present levels.

The promulgated strategy for Muskingum County is in paragraph 48 of the regulation.

X. Ottawa County

Ottawa County is located in northern Ohio along Lake Erie in the Sandusky Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data and was estimated to be 15 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Toledo and upper air data from Flint, Michigan for the year 1964.

All the identified sources in Ottawa County are sufficiently separated from one another to be considered isolated sources. Therefore the MAXT24 program was utilized in a separate analysis for each source. This program is described in Section IX. The modelling imput parameters as well as modelling results which were critical to strategy development are listed in Appendix A.

The individual dispersion analysis indicated second maximum 24 hr. values well below the standards. Using the individual results together with the PSD increment, the strategy allows limited increases above present levels. The strategy for the fuel combustion sources is above present levels and at the minimum emission limit after applying the respective increases to each source. The strategy for the process sources reflects the different capacities and the emission limits which include the strategy increases.

The promulgated strategy is in paragraph 49 of the regulation.

Y. Paulding County

Paulding County is in northwest Ohio in the Northwest Ohio Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring sites. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 30 ug SO_2/m^3. In order to investigate the present and potential impact of existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Dayton and upper air data from Dayton for the year 1964.

Only a single process source was identified in Paulding County, This isolated source was analyzed with the MAXT24 program described in Section IX. The modelling imput parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion analysis indicates that the second maximum 24 hr. concentration is 37 ug SO_2/m^3. Using the this result and the PSD increment, the strategy limits the source.

The promulgated strategy is in paragraph 50 of the regulation.

Z. Pickaway County

Pickaway County is located in central Ohio in the Metropolitan Columbus Intrastate AQCR. The present air quality indicates that the standard is presently attained. However a violation of the 24 hr standard was recorded in 1973. The background SO_2 level was determined from the available air quality data as described in Section II and was determined to be 118 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surfact meteorological data from Columbus and upper air data from Dayton for the year 1964.

All the identified sources in Pickaway County are geographically isolated from each other. Consequently the MAXT24 program was utilized in an individual analysis for each source. The modelling imput parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The largest single source in the county is the Columbus and Southern Ohio Power Company's Picway Power Plant. The analysis and strategy development of the source is described in Section IV. B. I.

The dispersion analysis indicates that for the remaining sources the second maximum concentrations were below the standard. Using the individual results and the PSD increment, the strategy allows limited increases from present levels. Applying this strategy increases to the coal burning sources resulted in an emission limit greater than 10.0 lbs SO_2/MMBTU. No potential problem is posed by these sources. The application of the strategy increases to the oil-fired sources did result in an emission limit.

The promulgated strategy for Pickaway County is in paragraph 51 of the regulation.

AA. PIKE COUNTY

Pike County is located in southern Ohio in the Wilmington Chillicothe-Logan Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was estimated from the available data as described in Section II and was estimated to be 25 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county dispersion modelling analysis was utilized with hourly surface meteorologicasl data from Huntington and upper air data from Huntington for the year 1964.

The only identified source in Pike County was analyzed with the MAXT24 prograsm which is described in Section IV. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion modelling analysis indicates that the second maximum 24 hr concentration from this source is 261 ug SO_2/m^3. Using this result and the background valve, the strategy allows a slight increase in emissions above present levels.

The promulgated strategy for Pike County is in paragraph 52 of the regulation.

BB. RICHLAND COUNTY

Richland County is located in north central Ohio in the Mansfield-Marion Intrastate AQCR. The present air quality in the county cannot be documented due to the lack of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 25 ug SO_2/m^3. In order to investigate the present and potential impact from existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Toledo ad upper air data from Flint, Michigan for the year 1964.

With the exception of the Ciy of Shelby Municipal Power Plant, all the remaining identified sources in Richland County are near the City of Mansfield. Because of the isolation of the Shelby facility, MAXT24 was utilized for the analysis of this source. For remaining sources MAXT24 was utilized to evaluate each source's individual impact and SCIM was utilized to evaluate the interaction of the sources. The modelling input parameters as well as the modelling results which were critical to the strategy development are listed in Appendix A.

The dispersion modelling indicated that the second maximum 24 hr concentration was 114 ug SO_2/m^3. Using this result and the PSD increment the strategy allows a slight increase above present levels.

The results of the SCIM analysis shows that the individual impacts of the sources rather than interaction between the sources is more critical for strategy development. The dispersion analysis indicates that on 9/11 days Westinghouse was the principle contributor to the critical receptor total of 286 ug SO_2/m^3. Using this result and the background value the strategy limits the source to a slight increase above the present level. At the critical receptor for Fisher Body, the 56 ug SO_2/m^3. Using this result and the PSD increment the strategy limits this source. For the remaining fuel combustion sources, the second maximum 24 hr concentrations and the PSD increments, the strategy allows limited increases above present levels. For these sources the resulting emission limits were greater than

10.0 lbs SO_2/m^3. Therefore no potential problems are posed from these sources.

The dispersion analysis of the process source indicated a second maximum concentration of 53 ug SO_2/m^3. Using this result and the PSD increments, the strategy limits this source.

The promulgated strategy for Richland County is in paragraph 53 of the regulation.

CC. ROSS COUNTY

Ross County is located in south central Ohio in the Wilmington-Chillicothe-Logan Intrastate AQCR. The available air quality monitoring data indicates attainment of the standard. The background SO_2 level was determined from the available data as described in Section II and was found to be 35 ug SO_2/m^3. In order to supplement the air potential impacts of the sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Columbus and upper air data from Dayton for the year 1964.

The Mead Paper Company is the only indentifiable source in Ross County. This source was analyzed with MAXT24 program described in Section IX. The terrain receptor elevations for this analysis were derived from the appropriate USGS topographic maps.

The Mead Paper Company is currently altering the SO_2 emission sources at their facility. In a letter dated May 12, 1976 from Russel E. Kross to USEPA, Mead has outlined the emissions sources as they will be in the near future. These changes will include shutdown of several sources. The strategy developed was based on the emissions as they will be in the near future. This will insure maintainance of the standards. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The dispersion modelling analysis indicates that the second maximum 24 hr concentration was 62 ug SO_2/m^3 and the second maximum 3 hr concentration 395 ug SO_2/m^3. Using these results and the respective PSD increments limits these sources. Applying these strategy increase to the fuel combustion Stack results in an emission limit greater than 10.0 lbs SO_2/MMBTU. An emission limit of this valve indicates no potential problem from this source. In a similar manner, the strategy increase was applied to the process stack to developed its strategy limit.

The proposed strategy for Ross County is in paragraph 54 of the regulation.

DD. SANDUSKY COUNTY

Sandusky County is located in northern Ohio in the Sandusky Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from available data as described in Section II and was estimated to be 15 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Toledo and upper air data from Flint for the year 1964.

Two of the identifical sources in Sandusky County are isolated from each other and freom the remaining sources which are a geographic group. T he two isolated sources were analyzed in individual MAXT24 runs. The remaining group of interacting sources were analyzed using SCIM. Both of these programs are described in detain in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis of the fuel combustion source indicated a second maximum 24 hr concentration of 16 ug SO_2/m^3. Using this result and the PSD increment, the strategy limits this source.

The MAXT24 dispersion analysis of the isolated process sources indicated a second maximum 24 hr concentration of 42 ug SO_2/m^3. Using this results and the PSD increment, the strategy limits this source.

The SCIM dispersion analysis of the grouping of process sources indicated that the total concentration at the critical receptor on 12/5 was 65 ug SO_2/m^3. The source-receptor contribution table indicates that all the sources interacted at this point. Usint the receptor's concentration and the PSD increment, the strategy limits these sources. A general process emission limit in the form of a single number or a sliding scale would not permit an equitable strategy increase for all the sources because of the great diversity of process capacities and sulfur contents of the fuels used by the sources. The strategy was refined for each facility such that a single emission limit was determined.

The promulgated strategy for Sandusky County is in paragraph 55 of the regulation.

EE. SCIOTO COUNTY

Scioto County is located on the south border of Ohio in the Huntington-Ashland-Portsmouth-Trenton Interstate AQCR. The present air quality date indicates that the standards have been attained in the county. The background SO_2 level was evaluated from the available air quality data as described in Section II asd was determined to be 13 ug SO_2/m^3. In order to supplement the potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Huntington and upper air data from Huntington.

The identified sources in Scioto County are isolated from each other. Consequently the MAXT24 program was utilized in a individual analysis for each source. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis of the Empire Detroit Facility indicates that the second maximum concentration is 23 ug SO_2/m^3. Using this result and the PSD increment the strategy limits this source. The optional lbs SO_2/MMBTU value allows the source the flexibility to utilize other fuel types of equivalent quality with respect to sulfur oxide emissions in their processes and boilers.

The MAXT24 dispersion model indicates the the second maximum 24 hour concentration was 84 ug SO_2/m^3. Using this valve and the PSD increment, strategy limits this source to a small increase above present levels. Since both coal and oil are conbusted, the strategy increase was applied uniformly to both fuel types.

The promulgated strategy for Scioto County is in paragraph 56 of the regulation.

FF. SENECA COUNTY

Seneca County is in north central Ohio in the Sandusky Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extra polated from available data as described in Section II and was estimated to be 20 ug SO_2/m^3. In order to investigate the present and potential impact of existing sources in this county dispersion modelling analysis was utilized with hourly surface meteorological data from Toledo and upper air data from Flint, Michigan for the year 1964.

The identified sources of Seneca County consist of a geographical grouping and some isolated facilities. The isolated facilities were analyzed with individual MAXT24 runds and the grouping of sources was analyzed using SCIM. Both of these programs are described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis of the Union Carbide facility indicates that the second maximum 24 hr concentration was 437 ug SO_2/m^3. Using this result and the background value, the strategy requires a reduction in emissions 20% from present levels. This reduction was applied uniformly for all the processes at the facility.

The MAXT24 dispersion analyses for the remaining isolated fuel combustion sources indicated that the standards are met. Using the individual results ad the PSD increment the strategy allows increases above current levels from individual sources.

The SCIM analysis of the remaining sources complex indicates a combined concentration from the interaction of these sources was 176 ug SO_2/m^3. Using the results and the PSD increment, the strategy allows the combined impact of these sources to increase slightly. This strategy increase was applied uniformly for both the process and fuel combustion sources.

The strategy selected for the fuel combustion sources was above the present level but not exceeding the minimum level after allowing the strategy increases.

The promulgated strategy for Seneca County is in paragraph 57 of the regulation.

GG. TUSCARAWAS COUNTY

Tuscarawas County is located in east central Ohio in the Zanesville-Cambridge Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from availabled data as described in Section II and was estimated to be 65 ug SO_2/m^3. In order to investigate the present and potential impact of the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Akron and upper air data from Pittsburgh for the year 1964.

All the identified sources in Tuscarawas County were geographically isolated from one another. Consequently each source was analyzed individually with the MAXT24 program described in Section IX. The modelling input parameters as well as the modelling results which were most critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis of the Dover Municipal Power Plant indicates that the second maximum 24 hr concentration is 187 ug SO_2/m^3. Using the result and the PSD increment the strategy limits the source to a slight increase above present levels.

The dispersion analyses of the remaining sources indicates second maximum 24 hr concentration below the standard. Using the individual results and the PSD increments, the strategy limits the increases allowed from individual sources. In each case the strategy emission limit was greater than 10.0 lbs. SO_2/MMBTU. Emission limits of this magnitude indicate that no problem is posed by those sources.

The promulgated strategy for Tuscasrawas County is in paragraph 61 of the regulation.

HH. VINTON COUNTY

Vinton County is located in south central Ohio in the Wilmington-Chillicothe-Logan Intrastate AQCR. The present air quality in the county cannot be documented due to the absence of monitoring stations. The background SO_2 level was extrapolated from the available data as described in Section II and was estimated to be 30 ug SO_2/m^3. In order to investigate the present and potential impact of the sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data freom Huntington and upper air data from Huntington for the year 1964.

The only identified source in Vinton County was analyzed in the MAXT24 program which is described in Section IX. The modelling input parameters as well as the modelling results which were critical for strategy development are listed is Appendix A.

The MAXT24 dispersion analysis indicated that the second maximum 24 hr concentration was 95 ug SO_2/m^3. Using this results and the PSD increment, the strategy allows a small increase above present levels.

The promulgated strategy is for Vinton County is in paragraph 62 of the regulation.

II. WASHINGTON COUNTY

Washington County is located in southeastern Ohio in the Parkersburg-Marietta Interstate AQCR. The present air quality in the county indicates that the standards have been met. However the monitoring sites are part of the power plants network and may not be reflective of the impact of the other sources in the county. The background SO_2 level was evaluated from available air quality data as described in Section II and was estimated to be 28 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impact from the existing sources in the county, dispersion modelling analysis was utilized with hourly surface meteorological data from Huntington and upper air data from Huntington for the year 1964.

All the identified sources in Washington County are geographically isolated rfrom each other. Therefore the MAXT24 program with each receptor terrain adjusted was utilized in an individual analysis for each source. This program is described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The largest sngle source in the county is the Ohio Power Company's Muskingum River Generating Station. The analysis and strategy development of the source is described in Section IV. B.I.

The dispersion modelling analysis of the Shell Oil Facility indicates that the second maximum 24 hr cncentration of 630 ug SO_2/m^3 and the second maximum 3 hr concentration is 1963 ug SO_2/m^3. Using these results and the background values, the strategy requires a 47% reduction from present level for this source.

The dispersion modelling results of the remaining source indicates the second maximum 24 hr concentration of 49 ug SO_2/m^3. Using this result and the PSD increment, the strategy allows an increase for the source. The resulting emission limit in excess of 10.0 lbs SO_2/MMBTU indicates that this source poses no problem.

The promulgated strategy for Washington County is in paragraph 63 of the regulation.

JJ. WAYNE COUNTY

Wayne County in located in northeast central Ohio in the Mansfield-Marion Instrastate AQCR. The air quality monitoring site in the county with stacastically sufficient data indicates atttainment of the standards. However the location of the site does not reflect maximal impact of the existing sources. The background SO_2 level was determined from the available air quality data as described in Section II and was estimated to be 77 ug SO_2/m^3. In order to supplement the existing air quality data and to investigate the potential impacts of existing sources, dispersion modelling analysis was utilized with hourly surface meteorological data from Akron and upper air data from Pittsburgh for the year 1964.

Except for two, the identified sources in Wayne County are sufficiently separated such that individual analyses utilizing MAXT24 was the basis for the strategy. The two source complex of PCA-Morton Salt was investigated with SCIM. Both of these programs are described in Section IX. The modelling input parameters as well as the modelling results which were critical to strategy development are listed in Appendix A.

The MAXT24 dispersion analysis for the Orrville Municipal Power Plant indicated a second maximum 24 hr concentration of 234 ug SO_2/m^3. Using this result and the background value, the strategy limits this source to slight increase above present levels.

The SCIM dispersion analysis for the PCA-Morton Salt complex indicates that the 24 hr concentration is 218 ug SO_2/m^3. Using this result and the background level, the strategy, allows a slight increase.

The source-receptor contribution table indicates that both sources are major contributors to this critical receptor. A single emission limit was developed such that the total contribution from both sources will meet the standards.

The MAXT24 dispersion analyses of the remaining sources indicated attainment of the standards. Using the respective results and the PSD increment, the strategy allows some increases above present levels. The resulting emission limits in all cases were greater than 10.0 lbs SO_2/MMBTU. An emission limit of this value indicates no problems from these sources.

The promulgated strategy for Wayne County is in paragraph 64 of regulation.

KK. WOOD COUNTY

Wood County is located in northern Ohio in the Metropolitan Toledo Interstate AQCR.

The analysis for Wood County differs from the other rural counties in that the only identifiable sources in the county are part of the Toledo urban area. The detailed description of this analysis is in Section IV. A.2.

The Wood County source are source numbers 17-21 in Toledo Region 4. The final strategy determined for Wood County is based on receptor 5 on Day 310 in run TS1 with a total concentration of 356 ug SO_2/m^3. The source receptor contribution table shows that the Wood County sources contribute 336 ug SO_2/m^3 to the total. The final strategy is approximately 5% above the input value to this run.

The promulgated strategy for Wood County is in paragraph 65 of the regulation.

3. Rural Counties with no Controls

In the twenty rural counties listed in Table 1, no sources presently exist. Therefore no control strategy is promulgated.

In the thirteen rural counties listed in Table 2, one or two isolated sources were identified. Each of these sources were analyzed in an individual MAXT24 run. This program is described in Section IX. The modelling input parameters as well as the modelling results are listed in Appendix A.

The MAXT24 dispersion an analysis indicates that the second maximum concentrations for each source is well below the standard. Using the individual results and the PSD increment as the limiting cases, strategy increases were allowed. Applying the strategy increase to the respective sources, emission limits in excess of 10.0 lbs SO_2/MMBTU resulted. An emission limitation of such magnitude indicates no problems are posed by these sources. Therefore no control strategy was promulgated.

For all these thirty-three counties, NAAQS for sulfur dioxide are attained and will be maintained without regulating controls on existing sources. Other currently existing regulations, namely New Source Review (NSR), New Source Performance Standards (NSPS), and Prevention of Significant Deterioration (PSD) will assure continued maintainance of the standards for new sources.

Table 1

1. Ashland County
2. Brown
3. Carroll
4. Champaign
5. Clinton
6. Darke
7. Fayette
8. Fulton
9. Harrison
10. Highland
11. Hocking
12. Jackson
13. Logan
14. Monroe
15. Morrow
16. Noble
17. Perry
18. Shelby
19. Union
20. Wyandot

Table 2

1. Defiance County
2. Geauga County
3. Guernsey County
4. Hardin County
5. Holmes County
6. Knox County
7. Madison County
8. Portage County
9. Preble County
10. Putnam County
11. Van Wert County
12. Warren County
13. Williams County

SECTION V

TECHNOLOGICAL AND ECONOMIC FEASIBILITY OF EMISSION LIMITATIONS

Section V. TECHNOLOGICAL AND ECONOMIC FEASIBILITY OF EMISSION LIMITATIONS

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SECTION V. TECHNOLOGICAL AND ECONOMIC FEASIBILITY OF THE EMISSION LIMITATIONS

INTRODUCTION

This Section discusses the general feasibility of the promulgated emission limitations through the use of current, proven retrofit control technology.

A. General Approach

The paramount consideration of the Clean Air Act is attainment and maintenance of the National Ambient Air Quality Standards (NAAQS), which are designed to protect the public health and welfare, through the reduction of pollutant emissions. The principal criteria for selection of the control strategies and subsequently the control technologies necessary to achieve attainment and maintenance of the ambient air quality standards is therefore effectiveness in reducing emissions and resulting impact upon air quality. The Clean Air Act does not require that consideration be given to the overall capital and operating costs which may be incurred to bring about the emission reductions necessary to attain the NAAQS. In fact, the legislative history of the Act suggests that the costs of reducing emissions were not to be considered an impediment to achieving the NAAQS (Sec. 116 Cong. Rec. 32901). The Administrator recognized, however, that arbitrary or capricious selection of control strategies may place undue hardship upon industry and the consumer. Ideally, least cost regional control strategies would be developed using mathematical constrained optimization techniques. Unfortunately, although development work is proceeding in this area, it will be several years before such techniques are available for practical application. Nevertheless, the mandate of the Clean Air Act requires attainment of the NAAQS as expeditiously as possible; and as a practical matter, the economic and technological feasibility of control strategies are evaluated to ensure their reasonableness.

The methodology utilized by EPA in developing the promulgated regulations was sufficiently detailed to enable the Agency to evaluate emission reduction requirements in terms of both their impact on ambient air quality and their technological feasibility at classes of industrial sources. In addition, EPA used contractor assistance to conduct site inspections under the authority of Section 114 of the Clean Air Act of facilities exemplifying various site specific considerations which might impede the implementation of a compliance program. The studies demonstrate that careful planning and the consideration of alternative compliance programs can overcome most site specific physical constraints. The twenty facilities inspected are listed in Section I(B)(2), and the contractor reports are available for review at the EPA Region V office. The remainder of Section V discusses the feasibility of the emission limitations at utilities and major classes of industrial facilities. The discussion does not indicate, and does not intend to indicate, that any particular technique will be technologically or economically feasible for every emission source covered by the proposed regulations. The owners and managers of emission sources have the responsibility to aggressively seek out the most cost effective means available to them to comply with the emission limitations adopted.

B. Control Technology Capability at Industrial Process Sources

1. Sulfur Recovery Plants

Sulfur recovery units are used to extract elemental sulfur from gas streams. In this regard they are similar to some scrubber systems.

Sulfur recovery units usually employ the Claus process. In this process, hydrogen sulfide and sulfur dioxide are allowed to react at elevated temperatures to produce elemental sulfur and water. If the feed gas contains only hydrogen sulfide, it is partially burned to sulfur dioxide so that the Claus reaction can occur. On the other hand, if the feed gas contains only sulfur dioxide, hydrogen sulfide is produced from the sulfur product and added to the feed. The Claus process, therefore, can be used for feed streams containing hydrogen sulfide, sulfur dioxide, or both.

Although most of the sulfur compounds in the feed gas are recovered, the exhaust gas from a Claus plant contains small amounts of unreacted sulfur dioxide and other sulfur compounds. The sulfur dioxide emissions can be reduced by using several Claus units in series, or by installing tail gas treatment systems. EPA has studied these alternatives and has found that high sulfur removal efficiencies are feasible. Claus plants with

2, 3, and 4 stages attain sulfur removal efficiencies of about 94, 96, and 98 percent respectively. A two-stage Claus plant with tail gas treatment can reduce sulfur content by 99 percent and more. The most stringent EPA standards for Ohio require sulfur removal efficiencies of about 97.5 percent. The standards can be achieved, therefore, either by multiple-stage Claus plants or by tail gas treatment systems.

Some of the available tail gas treatment systems are described below.

Beavon

The Beavon process is licensed by the Union Oil Company. In this process, tail gas from a Claus plant is heated by mixing it with the combustion products containing carbon monoxide and hydrogen from a reducing gas generator. The combined gas stream is then passed through a cobalt-molybdate catalyst bed where all sulfur compounds are converted to hydrogen sulfide. After leaving the catalytic reactor, the gas stream is cooled in a waste heat boiler and/or water quench tower, and then fed to a Stretford absorber. The absorbent is a solution of sodium carbonate, sodium metavanadate, and anthraquinone 2,7-disulfonic acid. This solution absorbs the hydrogen sulfide and reduces it to elemental sulfur. The solution is regenerated by blowing air through it, and at this time the sulfur accumulates on top as a froth. The sulfur is skimmed off and reclaimed.

EPA conducted eimission tests on a Beavon unit at Union Oil Company's Los Angeles refinery. The results showed that the feed to the Claus plant averaged 3204 pounds of sulfur per hour and the treated gas averaged 0.43 pounds of sulfur dioxide per hour(1). The sulfur removal efficiency therefore exceeded 99 percent.

Currently, 16 Beavon units are operating, and 15 additional units are under construction or in design in the United States, Virgin Islands, and Japan.

SCOT PROCESS

The Shell Claus Off-Gas Treating (SCOT) Process is licensed by Shell Development Company. The process is similar to the Beavon process but a different absorbent is used. In the SCOT process, the Claus tail gas is mixed with hot combustion gas from a reducing gas generator and passed over a cobalt-molybdate catalyst to convert the sulfur compounds to hydrogen sulfide. The gases are cooled in a waste heat boiler and a water quenching tower and are then sent to an absorber. There the gas is contacted with diisopropanolamine to remove the hydrogen sulfide. The outlet gas from the absorber containing small amounts of unabsorbed hydrogen sulfide is incinerated. The absorbent is regenerated by driving off the absorbed hydrogen sulfide in a stripper column, and the hydrogen sulfide is recycled to the Claus plant.

EPA performed emission tests on the SCOT unit operating at Champlin Petroleum Company's refinery at Wilmington, California in 1974. The results of three tests show that the feed to the Claus plant averaged 1213 pounds of sulfur per hour, and the treated gas averaged 8.04 pounds of sulfur dioxide per hour(2). The sulfur removal efficiency therefore exceeded 99 percent.

Thirty-five SCOT plants are under contract in the United States, Canada, Europe and Japan. At least 12 of these units are operating, 11 in the United States.

Wellman-Lord Process

The Wellman-Lord system is licensed by Davy Powergas Inc. In this process, tail gas is incinerated to convert all sulfur compounds to sulfur dioxide. The gases are cooled in a waste heat boiler and water quench tower, and then fed to an absorber. There the gas is scrubbed with a water solution of sodium sulfite. The clean gas from the absorber is discharged to the atmosphere, and the spent scrubbing solution is regenerated by evaporation. In the evaporators, the absorbed sulfur dioxide is driven off and recycled to the sulfur recovery unit. Not all of the absorbent can be recycled; a small purge stream is required to remove nonregenerable sodium sulfate produced in the absorber. The purge stream is treated to selectively remove sodium sulfate by crystallization, and then returned to the process. The sodium sulfate can be sold, discarded, or converted to recyclable sodium sulfite.

EPA has conducted emission tests on a Wellman-Lord unit installed on a Claus plant at Standard Oil of California's El Segundo Refinery. The average of three tests indicates that 10,484 pounds of sulfur per hour were fed to the Claus plant and that 1.81 pounds of sulfur dioxide per hour were emitted form the

Wellman-Lord unit (3). The sulfur removal efficiency therefore exceeded 99.9 percent.

IFP Processes

The Institut Francais du Petrole has developed two processes for treating tail gas; the IFP-1500 and the IFP-150.

The IFP-1500 process is an extention of the Claus reaction carried out in a liquid phase. Claus plant tail gas is injected into the bottom of a packed tower and scrubbed with polyethylene glycol in which a catalyst, a carboxylic acid salt, is dissolved. The catalyst promotes further reaction between hydrogen sulfide and sulfur dioxide forming elemental sulfur. The gases leaving the reactor are incinerated and then discharged.

EPA conducted emission tests on an IFP-1500 unit installed on a Claus plant operated by Stauffer Chemical Company in Delaware City, Delaware. The average of three tests shows that 31,710 pounds of sulfur per hour were fed to the Claus plant, and that about 352.7 pounds of sulfur dioxide per hour were emitted(4). The efficiency was therefore in excess of 98.5 percent.

The IFP-150 process is similar to the IFP-1500 but adds an ammonia scrubber to the system. The tail gas is scrubbed before going to the reactor, and the reactor exhaust gases are recycled to the scrubber before discharge. Additional sulfur removal in the ammonia scrubber should increase overall efficiency.

Four IFP-150 units are under construction or operating in France and Japan.

To obtain representative cost information for controlling sulfur dioxide emissions, EPA contracted a study on Standard Oil's Lima refinery in Allen County(5). This plant can process 180,000 barrels of crude oil per day and is the largest refinery in the State. Cost estimates were prepared for installing tail gas cleaning facilities on the existing Claus sulfur recovery unit. Capital costs for the Beavon and SCOT processes were estimated at $2.0 and $2.1 million respectively. The total operating costs were $541,000 and $652,000 respectively. These costs were based upon bringing a Claus sulfur recovery plant into compliance with the proposed emission limitation (0.1 lbs SO_2 per pound of sulfur processed) which required SO_2 emission reductions of about 91 percent.

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2. Sulfuric Acid Plants

Sulfuric acid is produced by several processes. In sulfur-burning plants, acid is produced by burning elemental sulfur with dry air in a furnance to produce SO_2. The SO_2 is then catalytically coverted to SO_3. The converter effluent is cooled and introduced into an absorption tower where SO_3 is absorbed in a sulfuric acid solution to form concentrated sulfuric acid by reaction with water. Other major types of sulfuric acid plants (spent acid and smelter gas plants) operate on the same principle as sulfur-burning plants except that SO_2 is obtained from the combustion of spent acid, Hydrogen sulfide or smelter off-gas. The emission of SO_2 to the atmosphere results from incomplete transformation of SO_2 to SO_3 in the converter.

EPA has promulgated a New Source Performance Standard (NSPS) for sulfuric acid plants that limits SO_2 emissions to 4 pounds per ton of acid produced. The background studies for this standard showed that control technology was available to meet the standard. At the time (1971) two control alternatives existed; Wellman-Lord Systems, and dual absorption. A more recent evaluation(2) shows two additional control processes to be commercially available; the Purasiv S process, and the Tysul System.

The four control processes are all being used commercially in the United States. All are technically capable of limiting emissions to 4.8 lbs. SO_2 per ton of acid produced, which is the most stringent acid plant standard promulgated in Ohio. The dual absorption system, however, cannot reduce SO_2 concentrations below 500 ppm because SO_2-SO_3 equilibrium is limiting. Those applications that may require SO_2 concentrations lower than 500 ppm to meet standards, cannot relay on dual absorption. The four control processes are described below.

Wellman-Lord.

This process is a regenerative SO_2 recovery process available from Davy-Powergas, Inc. Tail gas from the acid plant is scrubbed with a lean sodium sulfite solution which absorbs SO_2, coverting the sodium sulfite to sodium bisulfite. The clean gas leaves the absorber through a mist eliminator. The spent scrubbing solution is regenerated in an evaporator. When heated, the absorption rection is reversed, producing the original bisulfite solution and a concentrated stream of SO_2 gas. The bisulfite solution is recycled to the scrubber, and the SO_2 stream is dried and added to the main SO_2 feed stream.

The oxidation of a small amount of sodium sulfite to sodium sulfate creates the need to purge a portion of the solution from the system. This creates a chemical makeup requirement and potential waste disposal problem. Chemical requirements have been minimized by a system which selectively removes the sulfate by crystallization. The concentrated purge stream from this system can be dried for sale or disposal of the sulfate. Davy-Powergas is currently engaged in the development of processes to chemically reduce the sulfate back to sodium sulfite.

There are now 17 Wellman-Lord installations in commercial service world-wide, desulfurizing tail gas from sulfuric acid plants, Claus plants, and flue gas from boilers. Three of these are treating tail gas from acid plants in the United States. An additional 13 Wellman-Lord plants have been licensed (worldwide) and are in design or construction. The full scale acid plant units have demonstrated on stream availability of greater than 97 percent over 12 1/2 plant-years of operation. Effluent SO_2 levels of 200 ppm in the stack gas have been consistently achieved. This is approximately 3.1 lbs. SO_2/ton acid, which is well below the emission limitations in EPA's Ohio regulations.

Dual-Absorption. This process is an alternative design for the acid plant. In this process the tail gas leaving the primary absorber is passed through an additional reator to convert residual SO_2 to SO_3 and then dissolved in a second absorber. The amount of SO_2 that can be removed from the tail gas is limited by reaction kinetics and chemical equilibrium. The limit is about 500 ppm.(3) Because of this limitation, dual absorption plants will not meet emission limits below about 6.5 lbs. SO_2 per ton of acid, unless their feed streams contain at least 7 percent SO_2.

Purasiv S

This process developed and marketed by Union Carbide Corporation, is a fixed-bed absorption system for removing SO_2, SO_3, and acid mist from sulfuric acid plant tail gas. The absorbent is a tailor-made molecular sieve, also produced by Union Carbide. Regeneration of the molecular sieve produces a concentrated SO_2 stream that is recycled to the acid plant. Recovered SO_2 contributes a 2 to 3 percent increase in acid production.

Regeneration of the loaded molecular sieve beds is accomplished by purging with hot, dry air. There are two versions of the process which differ in the method of drying the air stream. If a source of acid-dried air is available it is used; otherwise the regeneration air is supplied by drying ambient air with an additional bed of molecular sieves.

In both versions, the tail gas passes through a blower, a cooler, and a high efficiency mist eliminator. The mist eliminator decreases acid mist in the tail-gas stream to less than 0.1 mg/scf. The tail gas then passes through a molecular sieve bed for selective absorption of SO_2 and SO_3. The molecular sieve is more effective and longer lasting when the tail gas is completely dry because water competes with SO_2 in the sieve lattice. Drying is accomplished by using a dessicant grade molecular sieve located in the absorber vessels in a compound bed arrangement. After passing through the absorbers, the tail gas is discharged to the atmosphere.

The first commercial unit was installed on a sludge acid plant in Oregon, Ohio, going on-stream in February 1973. Immediately afterward, a six-month study was performed on the system. The availability of the unit was very good, and SO_2 recovery from the tail gas was greater than 99 percent. Average daily effluent SO_2 concentration was in the 15 to 25 ppm range, equivalent to a daily emission rate of less than 0.4 lbs. SO_2/ton acid produced. The daily mean SO_2 concentration in the off gas was always less than 50 ppm, equivalent to 0.7 lb SO_2/ton acid.(2)

In November 1973, the original molecular sieve absorbent installed in February 1973 was replaced with a second generation sieve designed for longer life. During tests on this sieve in February 1975 emissions were less than 1 lb. SO_2/ton H_2SO_4. Operation of the unit is fully automatic and there are no by-products or waste steams. In addition, acid production is increased 2 to 3 percent by recycling the recovered SO_2. It is also possible to increase production since the SO_2 strength to the converter may be increased.(2)

Tysul Process.

This process was developed by E.I. DuPont Co., and uses a tail gas scrubber to react sulfur dioxide in the entering stream with Tysul to produce sulfuric acid. Tysul is DuPont's trademark for a specially stablilized 70 percent hydrogen peroxide solution. The scrubbing solution is 35 to 50 percent sulfuric acid containing 0.1 to 0.5 percent Tysul. The SO_2 absorbs and then reacts with the peroxide to form sulfuric acid. The addition of peroxide is automatically controlled to maintain a given SO_2 concentration in the exit stack.

The scrubbing liquor is continuously recirculated. A purge stream is drawn off to maintain a constant sulfuric acid concentration via an automatic flow control loop. The purge stream is passed through a thermal reactor to decompose residual peroxide, and is then returned to the acid plant as a substitute for normal dilution water in the absorber. The peroxide is decomposed to avoid discoloration of the product acid. In the event of a thermal decomposition reactor breakdown, the purge stream is either temporarily held up in the scrubber pump tank or transferred untreated to a holding tank.

The Tysul process has been operating successfully at DuPont's East Chicago Plant since November 1972, and is meeting the East Chicago Air Control Ordinance level of 6.5 pounds of sulfur dioxide per ton of sulfuric acid produced. The process is stable and there are no waste streams.

The Tysul process is not actively marketed at this time, probably due to the high cost of hydrogen peroxide ($0.4/lb) on the open market. This cost would be particularly prohibitive where SO_2 concentrations are high.

In order to determine representative costs for SO_2 controls, a cost analysis has been made for the E.I. DuPont Company's Cleveland plant.(2) Actual costs for the Tysul process installed at the plant were supplied by DuPont. Estimated costs for comparable Wellman-Lord and Purasiv S control systems were obtained from a study done by Battelle Columbus Laboratories.(4) Capital and annual operating costs were about the same for all three processes, as shown in Table 1.

Table 1. ESTIMATED INVESTMENT AND ANNUALIZED COSTS FOR RETROFITTING DUPONT'S CLEVELAND SULFURIC ACID PLANT WITH SO ABATEMENT SYSTEMS(4)

	Union Carbide "PuraSiv S"	DuPont "Tysul"	Davy-Powergas Wellman-Lord
Total capital investment, million $	2.74	2.8	3.0
Total annualized cost, thousand $	714	750	750

Includes annualized capital charge, annual operating and maintenance charges.

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3. By-Product Coke Oven Facilities

Coke ovens are used to produce coke by roasting coal in the absence of air. The volatiles driven off are collected as a byproduct fuel. The coke is used in the manufacturer of iron and steel; the coke oven gas is burned to heat the coke ovens and to provide other process heat. The coke oven gas contains sulfur, in the form of hydrogen sulfide, which forms sulfur dioxide when burned.

The EPA regulations limit the amount of sulfur that can be burned in coke oven gas or, equivalently, the amount of sulfur dioxide that can be emitted in the combustion products. The most stringent limitation is 35 grains of hydrogen sulfide per 100 dry standard cubic feet of coke oven gas burned or, equivalently 0.10 pounds of sulfur dioxide emitted per million BTU of heat input.

The regulations can be met by desulfurizing the coke oven gas before it is burned. Several adequate processes are available and are currently being operated at nine United States plants. Two more are under construction and two are committed to construction. Two general control approaches are feasible; the liquid absorption process, and the wet oxidative process. Examples of each are discussed below.

Three liquid absorption processes, Vacuum Carbonate, Sulfiban, and Firma Carl Still involve similar unit operations. Raw coke oven gas is cleaned by absorption of acid gases in sodium carbonate, monoethanolamine, and ammonia respectively. Steam is then used to strip the acid gas from the absorbing medium to regenerate the absorbent. Particularly in the Vacuum Carbonate system, higher hydrogen sulfide collection efficiencies require large increases in steam consumption to regenerate a clean absorbent. The gases from the stripper column are then sent to a sulfur recovery unit before discharge. Claus plants are generally used for sulfur recovery but some newer systems will use sulfuric acid plants (Claus plants and acid plants are both subject to additonal sulfur dioxide regulations if applicable). Before entering the sulfur recovery unit, the gases must be treated to remove hydrogen cyanide, or corrosion and plugging will occur.

Vacuum Carbonate Process

The vacumm carbonate process has been marketed by the Koppers Company since the mid 1950's. In this process, hydrogen sulfide is removed by scrubbing with sodium carbonate. The scrubbing solution is regenerated in a steam stripping column, maintained at a partial vacuum. Hydrogen sulfide and steam leave the top of the stripper and go to a condenser; the condensed water is returned to the system and the hydrogen sulfide gases are sent to another unit for hydrogen cyanide removal (discussed later), and then to a sulfur recovery system.

The vacuum carbonate process was originally designed for 90 percent removal efficiency, equivalent to an exhaust of about 50 grains of hydrogen sulfide per 100 scf. Since 1973, Koppers has offered a 93 percent efficiency design, but at substantially increased steam and utility costs(1). A two-stage system, tested on a pilot scale, reportedly reduces emissions to 10 grains of hydrogen sulfide per 100 standard cubic foot.(1).

Sulfiban Process

The Sulfiban process, developed by Bethelem Steel Corporation and Black, Sivalls and Bryson Process Systems Inc. and marketed by the latter organization, is being utilized at two plants and two units are under construction at other plants. This is a relatively new process with full scale units in operation for less than 3 years. An alkanolamine solution (13 to 18 percent monoethnolamine) is used as an absorbent. Sulfiban pilot units have demonstrated their ability to clean coke oven gas to 10 grains or less of hydrogen sulfide per 100 scf(2). Commercial operation has substantiated the pilot plant results. The Shenago plant has operated at absorption efficiencies in the high 90 percent range. The Bethlehem Pennsylvania plant, designed to process 100 million scf/day of raw coke oven gas containing 325 to 375 grains hydrogen sulfide per 100 scf, has sweetened coke oven gas to a 4 to 6 grains hydrogen sulfide per 100 scf level(3).

The degree of desulfurization is dependent upon the monoethanolamine (MEA) solution circulation rate, the temperature of the solution, and the reboiler steam rate. Higher desulfurization levels increase the steam requirement for regenerating the amine solution. The steam requirement for desulfurizing to a 10 grain hydrogen sulfide per 100 scf level is approximately double that required for a 50 grain level.

An advantage of amine desulfurization utilized in the Sulfiban process is the simultaneous removal of organic sulfur. This can be important since the emission regulations limit total sulfur content expressed as hydrogen sulfide equivalent. Typical organic sulfur content of raw coke oven gas at the Bethlehem plant ranged from 3 to 8 grains (hydrogen sulfide equivalent)/100 scf or less(3). The Sulfiban process is the only liquid absorption process which removes organic sulfides.

As the MEA solution cycles through the system, small quantities of thermally stable compounds such as ferrocyanide and formamide are formed. To prevent the build-up of these compounds, a purge stream is sent to a reclaimer where the MEA is recovered by distillation and the residue is discarded. This sludge contains iron sulfide, prussian blue, thiourea, etc. Approximately one barrel per day of sludge is produced from a plant processing 60 million scf/day of coke oven gas. Mixing the sludge with sinter plant feed is one disposal method which has been utilized.(2)

As with the Vacuum Carbonate system, a hydrogen cyanide treatment facility is necessary to prevent Claus plant operating difficulties. This facility is discussed later.

Firma Carl Still Process

The Firma Carl Still Process was developed in Germany. It is currently licensed in the United States by Dravo Corporation as the Dravo-Still process. In this process, precooled ammonia scrubs the coke oven gas to remove hydrogen sulfide. The clean gas leaving the desorber is released to the atmosphere and the scrubbing solution is regenerated, by steam stripping. The gas leaving the stripper containing about 40 percent hydrogen sulfide is sent to a sulfur recovery unit.

Dravo proposes to use the process to eliminate Claus plant tail gas. Unconverted sulfur dioxide and hydrogen sulfide in the tail gas would go to a catalytic furnace to be burned with coke gas and insufficient air. This would reduce all sulfur compounds to hydrogen sulfide. The resulting gas would be cooled and recycled to the hydrogen sulfide absorber.

The efficiency of the Firma Carl Still process depends on the ammonia concentration of the scrubbing solution and its temperature. At some plants a chiller will be needed during the summer. The process is capable of reducing sulfur content to about 10 grains of hydrogen sulfide per 100 scf. Since organic sulfur compounds are not absorbed, desulfurization is limited by their concentration (usually 5 to 10 grains per scf).

The first United States system is expected to start up in mid 1976 at Armco Steel's plant in Middletown, Ohio. Wheeling Pittsburgh Steel has also made commitments to install a system for a 90 million scf per day plant.

Hydrogen Cyanide Treatment For Liquid Absorption System

Hydrogen cyanide in the exhaust gases from liquid absorption processes must be treated before sulfur recovery. Corrosion and plugging of Claus plants due to hydrogen cyanide has been a serious problem, responsible for most reliability and technological problems associated with liquid absorption systems. Concentrations of hydrogen cyanide should be below 1 percent for successful operation of normal Claus systems.

Water washing is the oldest method of hydrogen cyanide removal and was utilized by Koppers on a Vacuum Carbonate system in the late 1940's. After hydrogen cyanide is absorbed it must be recovered as a product or stripped from solution and incinerated.

Bethlehem Steel Corporation in conjunction with Black, Sivalls, and Bryson has developed a process incorporating a cyanide destruct reactor to eliminate hydrogen cyanide problems in the operation of Claus plants. Acid gases are preheated, then sent to the reactor where they are blended with a small quantity of air in the presence of a bauxite catalyst(3). The hydrogen cyanide is destroyed by oxidative sulfurization and by hydrolysis. For each mole of hydrogen cyanide destroyed, one mole of ammonia is produced. Concentrations of carbon dioxide, carbon monoxide, and organic sulfides also increase.

Since ammonia and organic sulfides are major sources of Claus reactor inefficiency, the following modifications in the Claus unit and operation are required. The burner/oven temperature must be maintained at greater than 1900°F by adding fuel gas as necessary. This causes the pyrolytic decomposition of ammonia to nitrogen and hydrogen. The first catalytic reactor in the Claus unit must be modified to convert organic sulfides to sulfur. A more active catalyst is also necessary.

A full scale cyanide destruct unit and modified Claus unit has proven effective at Bethlehem Steel Company's Lackawana plant. Hydrogen cyanide concentration has been reduced from 16.1 percent to 0.2 percent, and corrosion problems due to hydrogen cyanide have been eliminated(4). Black, Siralls and Bryson is currently marketing this system as an integral component of their Sulfiban process. However, the cyanide destruct system can be used with other liquid absorption processes. In fact, Inland Steel has made a commitment for construction of a hydrogen cyanide destruct unit and Claus plant on a Vacuum Carbonate system at Indiana Harbor Works.

A catalytic cracking process for decomposing hydrogen cyanide has been developed by Firma Carl Still and utilized in Germany with success(1). This system operates at 1500 to 2000°F and is part of a modified Claus furnace. The hydrogen cyanide is cracked to hydrogen, carbon monoxide, and nitrogen, and any traces of ammonia remaining in the acid gas stream are also converted to nitrogen and hydrogen as in the Sulfiban system. Dravo is marketing this system as part of the Dravo-Still process in the United States.

A fourth approach has been investigated by Koppers. This modification of the Claus plant combustion chamber to improve hydrogen cyanide incineration was installed on a Vacuum Carbonate system at Bethlehem Steel Corporation's plant at Burns Harbor, Indiana.(2)

Wet Oxidative Processes: Holmes Stretford

Wet oxidative processes, such as the Holmes-Stretford, differ from liquid absorption systems in that hydrogen sulfide is oxidized to elemental sulfur while still in the absorbing medium. Elemental sulfur is then simply recovered, without a Claus plant, by filtration. In this type of system the steam consumption is greatly reduced, about 80 to 90 percent, as the stripping step is eliminated. In addition capital costs may be lower since a Claus plant or a sulfuric acid plant is not needed. However, hydrogen cyanide is a very serious problem for these systems and must be removed before it enters the absorber or consumption of the expensive chemicals will be excessive.

The complete Holmes-Stretford process, now being marketed by Wilputte Corporation in the United States, uses the Holmes process for treatment of liquid waste streams resulting from hydrogen cyanide absorption and the Stretford wet oxidative system for hydrogen sulfide absorption. Dominion Foundry and Steel Ltd., in Hamilton, Ontario, Canada is the only plant in North Anerica using the Stretford process. They have ordered a Holmes fixed salt recovery system for treatment of the liquid waste stream.

Vanadium, anthraquinone disulfonic acid, anhydrous citric acid, and sodium carbonate are circulated through the absorber. After hydrogen sulfide is dissolved in the liquid it is oxidized to sulfur as the vanadium is reduced from its pentavalent form to its quadrivalent state. The anthraquinone disulfonic acid is employed as an oxidant to regenerate the vanadium to the pentavalent state. During this reaction, the anthraquinone is reduced to semiquinone which is reoxidized back to anthraquinone with air. This absorption oxidation system is capable of achieving hydrogen sulfide removal efficiencies of over 99 percent. Overall sulfur removal efficiency is primarily a function of the concentration of organic sulfides in the coke oven gas.

The chemical reagents used in the Stretford process react irreversibly with hydrogen cyanide to form thiocyanates and other salts. This increases the amount of blowdown needed and the make-up chemicals required. Besides increasing the quantity of waste from the process, chemical costs can be prohibitive (anthraquinone disulfonic acid costs about $5/lb). Hydrogen cyanide must therefore be removed before the absorber.

Dominion Foundry is using a polysulfide pretreatment system with an ammonia absorbent. Dominion has been able to achieve a 90 percent cyanide removal efficiency, and higher removal efficiencies may be possible using a sodium-based absorbent. Wilputte is currently using sodium carbonate in their pretreatment systems.

The reactions are carried out by passing the COG counter current to the sodium polysulfide liquor in a scrubbing tower. A side stream of the circulating liquor is withdrawn and passed through the polysulfide regenerator. A blow down stream purges reacted salts.

The major problem with the Stretford process is the large quantity of liquid waste containing high concentrations of thiocyanates, polysulfides, thiosulfates, etc. This problem has limited the application of the Stretford system up to this time. These wastes can reportedly be treated by the Holmes process in which the effluent is incinerated in a refractory lined furnace under proprietary conditions. The products are recycled, and there are no effluent streams. The first full-scale system began operation at the British Steel Corporation Orgreave Works in July, 1975. After the initial start-up and shakedown period, the fixed salts recovery system reportedly has worked well.

To determine costs of retrofitting controls, EPA contracted studies on two plants in Ohio that operate by-product coke ovens. The cited costs include the costs of cleaning the coke oven gas and recovering the sulfur in a Claus plant.

The Youngstown Sheet and Tube Company operates three coke oven batteries at their plant near Youngstown in Mahoning County. With a total capacity for 5600 tons of coal per day, the plant size is about average. Cost estimates were prepared for the Sulfiban, Firma Carl Still, and the Holmes-Stretford systems(5). The total capital costs are, respectively, $10, $9.5 and $7.5 million. Total annual operating costs are, respectively, $1.41, $1.29, and $0.862 million.

The second plant chosen for study is Republic Steel Corporation's Cleveland steel plant in Cuyahoga County. This large integrated mill produces 2.5 million tons of steel a year.

There are two separate coke plants on site; the combined capacity is about 7550 tons of coal per day. Cost estimates were obtained for the same three processes; Sulfiban, Firma Carl Still, and Holmes-Stretford[6]. The total capital costs are, respectively, $17.2, $17.2, and $15.1 million. Total annual operating costs are, respectively, $4.5, $4.1, and $3.9 million.

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4. Refining Operations

Refineries process crude petroleum into gasoline, heating oil and many other products. Many separate processes are involved and emit sulfur dioxide in some of the processes. Of these, the major sources are subject to regulations. Two of the sources (sulfur recovery units and industrial boilers) are discussed elsewhere. Sources specific to refineries are considered here. These include the various units that burn refinery process gas, and catalytic crackers.

Process Gas Burners

Refinery processes, such as distilation, delayed coking, and fluid catalytic cracking, generate substantial quantities of gas as a product. The "process gas" is used as fuel in process heaters and boilers throughout the refinery. Process gas may contain as much as 5 percent hydrogen sulfide in volume, which burns to sulfur dioxide.

The most common method for controlling the sulfur dioxide emmisions is to pretreat the process gas for hydrogen sulfide removal. Monoethanolamine (MEA) and diethanolamine (DEA) scrubbing units are widely used for this purpose. The process gas leaves the scrubber ready for use as a fuel; the MEA or DEA is regenerated in a stripper column and returned to the absorber. Hydrogen sulfide rich gas leaving the stripper is sent to a condenser for water removal, and then by a sulfur recovery unit before discharge.

Due to thermal and chemical degradation, amine solutions require periodic replacement or treatment. In MEA treating systems, it is common practice to send a continuous slipstream of amine solution to a heated reclaimer. There, caustic soda is added and MEA is disassociated from complex salts, distilled and returned to the regenerator tower. As the salt content in the reclaimer increases, it is necessary to purge the salts and recharge the reclaimer. For a typical 200,000 bbl/day refinery producing 30 x 10^6 dscf of process gas, about 2000 lb/month of waste salts may be formed. Water is added to reduce the viscosity of salt slurry before disposal by incineration or landfill.

Diethanolamine has a higher boiling point than MEA and cannot be similarly treated. Usual practice is to continue operating until the solution is spent and the hydrogen sulfide content of treated gas reaches undesirable levels. The entire solution is then replaced with fresh solution. In the typical refinery cited above, approximately 50,000 gallons of solution containing 20 percent DEA and 10 percent complex salts would have to be removed annually.

EPA has promulgated new source performance standards, for the combustion of refinery process gas.(1) Before setting the standards a study was made of control capabilities. It was found that the MEA and DEA scrubbers could remove more than 99 percent of the hydrogen sulfide, leaving a process gas containing no more than 0.10 grains of hydrogen sulfide per dry scf.(2) Burning such a fuel will result in combustion products containing less than 20 parts per million of sulfur dioxide. For comparison, a fuel gas containing 20 parts per million sulfur dioxide is roughly equivalent to a fuel oil containing 0.04 percent sulfur by weight.

Catalytic Crackers

Catalytic cracking is a process used to convert heavy oils to gasoline and other products. This is done by "cracking" large hydrocarbon molecules into smaller ones. Cracking is accomplished either by heating the heavy feed oil in the absence of air (thermal cracking), or in the presence of a catalyst (catalytic cracking). Only the latter process is governed by EPA's Ohio regulations, and is the only process considered here.

In catalytic cracking, the feedstock is mixed with catalytic particles such as silica or alumina and sent to a heated reactor. At least originally, the catalyst was maintained in the reactor as a fluidized bed, and the process came to be called fluid catalytic cracking. The product vapors leave the top of the reactor through cyclones, which return entrained catalyst particles to the reactor, and go to a distillation column (fractionator) to be separated into gasoline and other products. Catalyst is removed from the reactor in a continuous stream and sent to a regenerator. There the catalyst is roasted in air to burn off carbon and sulfur deposits and then returned to the reactor. The combustion gases leaving the regenerator pass through cyclones to remove catalyst fines and are then burned in a boiler (called a CO boiler) to generate process stream. The sulfur burned from the catalyst during regeneration is ultimately emitted as sulfur dioxide from the CO boiler.

Sulfur dioxide emissions from a typical fluid catalytic cracking unit processing 50,000 barrels of feed per day, are about 1200 pounds per hour; the sulfur dioxide concentration in the off gases from the regeneration and from the downstream CO boiler is above 1000-1400 parts per million.

The most stringent regulation in the Ohio plan requires a 97.5 percent reduction in sulfur dioxide emissions. This standard applies to a plant that currently sends the exhaust gas to a Claus plant with tail gas treatment can achieve removal efficiencies of 99 percent and higher.

Standards for other catalytic crackers limit the mass of sulfur dioxide that can be emitted per 1000 pounds of product or feed. The most stringent of these standards is 0.2 pounds of sulfur dioxide per 1000 pounds of charging stock. Control technology is available to meet the standards, as summarized below.

EPA recently conducted a screening study of fluid catalytic crackers investigating, among other things, available controls.(3) Sulfur dioxide emissions can be limited by: a) using low sulfur feeds, b) pretreating the feed, and c) desulfurizing the exhaust gases.

Switching to low sulfur feeds is the easiest alternative and imposes minimal capital investment. Because of shortages, low sulfur feed will not always be available.

Pretreatment of feedstocks is accomplished by hydrotreating. This common process involves reacting the feedstock with hydrogen to convert sulfur compounds to hydrogen sulfide, which is then sent to a sulfur recovery unit. Hydrotreating is used in various processes to improve product quality or to prevent sulfur poisoning of catalysts. Its use as a control method in catalytic cracking operations will be limited by the expense of generating hydrogen and by the possible disadvantageous alteration of product quality.

Desulfurization of exhaust gas is a control alternative that should be applicable to any catalytic cracker. Many processes have now been developed for this general purpose and can be applied to catalytic cracking units. So far, only a few units have been controlled. Two Ohio units send (or plan to send) the off gases to Claus plants where over 99 percent removal is feasible.

The scrubbers now being installed on utility boilers have not yet been applied to catalytic crackers but should be applicable. The cracking units exhaust about 1000 parts per million sulfur dioxide, which is similar to sulfur levels in utility boiler exhausts. Also, the scrubbers have demonstrated their ability to handle gas streams with fine particulate matter entrained.

The Exxon Corporation has developed, and now markets, a scrubber specifically designed for catalytic cracking units.(4) This scrubber is known as the Exxon jet ejection liquid scrubber. It employs a scrubbing solution of sodium hydroxide in a once-through process to remove sulfur dioxide and particulates simultaneously, the scrubbing solution is pumped through atomizing jets into the top of a venturi scrubber. The jet spray aspirates the dirty gas into the venturi where scrubbing occurs. The combined gas-liquid effluent enters a large separator drum where the liquid falls out and is removed. The clean gas passes overhead through a demister to the stack. The scrubbing solution is recycled to the venturi except for a purge stream that prevents buildup of sulfites and sulfates.

Exxon has installed its scrubber on two catalytic cracking units at the Exxon refinery in Baytown, Texas; startup dates were March 1974 and May 1975. Two more installations will startup in 1976; they will be at Baton Rouge, Louisiana and Bayway, New Jersey.

The operation of the Baytown, Texas units has been good. Service factors for the two units have been 94 and 93 percent respectively since 1975. The sulfur dioxide removal efficiency has been greater than 90 percent.

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C. Control Technology Capability at Fossil Fuel Fired Steam Generators

1. Utilities

Utilities produce electric power from steam-driven turbines. The steam is generated on site in large boilers fired with fossil fuel; either gas, oil, or coal. Sulfur present in the fuel burns to SO_2 and becomes part of the off gas; the amount of SO_2 is determined by the sulfur content of the fuel.

EPA has promulgated New Source Performance Standards (NSPS) for large power plants. The SO_2 limitations for oil-fired and coal-fired units are respectively, 0.8, and 1.2 pounds per million BTU of heat input. (No standard is needed for gas-fired units because natural gas contains no sulfur.) The background studies for these standards showed that control technology was available to meet the standards. (1) The control alternatives were to use low sulfur fuels or to install flue gas desulfurization (FGD) equipment. These remain the main alternatives today, coal cleaning is a third alternative that in some cases may be sufficient or at least helpful.

EPA's standards for Ohio utilities are plant specific. The most stringent standards for oil and coal-fired plants are respectively, 0.6 and 1.14 pounds SO_2 per million BTU heat input. The standards can be achieved either by burning low sulfur fuel or by installing FGD equipment. In some cases the standards can be met by coal cleaning either by itself or in combination with low sulfur fuel or FGD. These control alternatives are discussed below.

Low Sulfur Fuel

Since the SO_2 in power plant stack gases results from the combustion of sulfur present in the fuel, the amount of SO_2 in the gases can be controlled by limiting the sulfur content of the fuels. The standards for Ohio can be met in this way. The allowable sulfur content depends on the heat content of the fuel and the specific emission limitation. Table 1 shows allowable sulfur levels of coal with a typical heating value of 11,000 BTU per pound. Table 2 gives similar information for a typical oil containing 18,000 BTU per pound. Allowable sulfur levels for other coals and oils are directly proportional to this heat content.

Table 1. Allowable Sulfur Levels for Coal Containing 11,000 BTU Per Pound

Emission Limitation lbs SO_2/million BTU	Allowable Sulfur %
1.2	0.65
2.0	1.0
3.0	1.6
4.0	2.2
5.0	2.7
6.0	3.2

Table 2. Allowable Sulfur Levels for Oil Containing 18,000 BTU Per Pound

Emission Limitation lbs SO_2/million BTU	Allowable Sulfur %
0.6	0.5
1.0	0.8
2.0	1.6

When low sulfur coal is burned, the fly ash has a higher resistivity than ordinary coal. This properly makes the low sulfur fly ash more difficult to collect in electrostatic precipitators. If a power plant switches to a low sulfur coal, therefore, there is a possibility that particulate emissions will increase.

The increased particulate emissions from low sulfur coal can be handled by upgrading the design of the electrostatic precipitator, such as by increasing precipitator size. At existing plants, however, the more common method is to condition the flue gas by the addition of chemical agents. The usual agent is sulfur trioxide, which in small amounts will lower the resistivity of fly ash and improve its collectability. Numerous other agents designed to generate SO_3 have been tried. The overall environmental effect of the agents is uncertain, since they may cause increased sulfate levels in the stack of ambient air.

The above considerations should be evaluated before a plant commits itself to low sulfur fuel. The desirable procedure is to make a test burn with the proposed low sulfur coal so that SO_2 and particulate measurements can be made. If a flue gas conditioning agent is to be used, it should be tested at the same time.

Coal Cleaning

Coal cleaning is a commercially available technology used to remove ash and pyritic sulfur from coal. All coal used for the production of metallurgical coke is cleaned, but only small quantities of utility coal are cleaned. However, coal cleaning is a potential control technology for utilities and other fuel combustion sources.

Sulfur in coal occurs in three forms: organically bound sulfur, pyritic sulfur, and sulfate sulfur. As much as 80 percent of the pyritic sulfur can be removed by coal cleaning techniques. Unfortunately, pyritic sulfur accounts for only 40 to 50 percent of the total sulfur content of the coal used in Ohio. About 80 percent of the coal used by Ohio utilities in 1972 came from three seams (Seams 6, 8, and 9, with most of the remainder coming from three additional seams (Seams 4,5, and 7)). Eighty-seven coal samples were taken from the six forementioned seams and analyzed in terms of potential SO_2 emission reduction attainable through coal cleaning. The results of this analysis are shown in Table 3.

Table 3. Reduction in SO_2 Emission Through Coal Cleaning(2)

•Seam	SO_2 Emissions (10^6/BTU) Raw Coal	% Reduction of SO_2 Emissions through Coal Cleaning	Resulting SO_2 Emissions 10^6/BTU
4	4.74	38.08	2.93
5	6.06	52.39	2.89
6	5.24	52.02	2.51
6A	7.00	47.91	3.65
7	6.18	44.95	3.40
8	6.31	24.93	4.74
9	6.78	23.47	5.18

The calculations which produced the data of Table 3 take into consideration the favorable 94-98 percent BTU retention of the washed coal. The degree of sulfur reduction or "cleanability" varies with the type of coal and how the sulfur is tied up in the coal. Recent studies(2) in Ohio coals showed that about 10 percent of the coals studied could be cleaned to a level that could meet a 1.6 pounds SO_2 per million BTU level (approximately 1.1 percent sulfur coal). Approximately 30 percent of the coals tested could be cleaned to meet a 2.8 pounds SO_2 per million BTU emission limit. These results indicate that a substantial potential exists for the reduction of SO_2 emissions through cleaning Ohio coal.

The successful application of coal cleaning technology depends on detailed washability studies of representative samples of a sources feed coal. The design of a coal cleaning plant should be based on the results of such studies. It is estimated that the range of capital investment for coal cleaning facilities is from 3,000 to 15,000 dollars per ton of coal processed per hour. Operating costs vary from fifty cents to one dollar per ton of refuse.

These costs should be balanced against potential benefits from the use of cleaned coal. The potential benefits include improved boiler availability, lower boiler operating and maintenance costs, reduced slagging, reduced need for particulate control (coal preparation lowers ash content) and reduced transportation costs. If FGD is also required, coal cleaning can reduce the capital, operation and maintenance costs for a FGD system.

Flue Gas Desulfurization (FGD)

Many different FGD processes are operational at present. The most common types in the United States are the lime and limestone scrubbers. In these processes the dirty gas passes through a scrubber where it is brought into contact with a water solution or slurry of either lime or limestone. The SO_2 is drawn into the solution and the clean gas passes through a demister to the stack. The spent scrubbing liquor is treated to remove the sludge formed when SO_2 reacts with the lime or limestone; the liquor is then recycled to the scrubber. The sludge is deposited in a permanent landfill area.

Limestone scrubbers are currently designed and operated at SO_2 removal efficiencies of about 80 percent. Efficiencies of 90 percent and higher are possible but so far have not been needed to meet the regulations. Lime scrubbers have demonstrated efficiencies of 90 percent and higher. These efficiencies are adequate to meet EPA's Ohio regulations. For example, consider a power plant burning coal with a sulfur content of 3.5 percent and a heating value of 11,000 BTU per pound. The uncontrolled SO_2 emissions would be about 6.2 pounds per million BTU heat input (3200 ppm). To meet the most stringent of EPA's Ohio regulations (1.14 pounds per million BTU) 82 percent of the SO_2 emissions must be removed. This is within the capability of both lime and limestone scrubbers currently operating. Clearly, if coal with a higher sulfur content or a lower heating value is burned, the FGD system must operate at a higher efficiency. The worst case situation might result from coal with 8 percent sulfur and 11,000 BTU per pound. For this coal to meet the 1.14 pounds per million BTU standard, a removal efficiency of 93 percent would be required. Even this worst case situation could be brought within the most stringent regulation with currently operating lime scrubbers.

The reliability of lime and limestone FGD system has been controversial in the last several years, because of problems with operating systems. The major problems have been corrosion, erosion, scaling, and plugging. These problems have caused frequent shutdowns and rapid wear of equipment. Solutions to the problems are evolving steadily through operating experience. The problems and solutions are now sufficiently understood that FGD systems can be designed and operated with good reliability.

Corrosion and erosion problems have been most serious in slurry recycle pumps, piping, and reheaters. (Reheaters are used to reheat the gas leaving the scrubber.) Rubber linings have been found to be very effective where they can be applied; this includes pipies and pumps, but not reheaters. The reheater problem can be solved by using direct flame gas or oil burners instead of steam tubes. (Some operators, however, prefer the steam heaters and are trying corrosion resistant stainless steels to fabricate the tubes.)

Scaling occurs when relatively insoluble sulfites and sulfates precipitate from solution onto the scrubber internals. If the scale chips off it can damage pumps or plug strainers. Plugging is a similar problem that occurs in demister sections; here the build up of deposits in the narrow passages can severely restrict the flow of gas, forcing a shutdown. The ideal solution for scaling and plugging is to control the system chemistry to prevent their occurrence. Louisville Gas and Electric has had complete success in this regard with their lime scrubber at Paddy's Run; by controlling the pH and solids concentration of the scrubbing solution, scaling and plugging have been eliminated. Limestone systems are more difficult to control, and all operating systems require routine shutdowns for chipping out the scale deposits and removal of demister plugs. Some systems are now being designed with several modules in parallel, with provision for one extra module. The modules can then be rotated in service with one module free for cleaning. This spare-tire arrangement will greatly increase the reliability of the overall system.

As of January 1976, about 21 FGD units were operating in the United States, with a total capacity of 3796 megawatts. About 20 units were under construction and about 67 were in the planning stages; these new units will have a combined capacity of about 31,000 megawatts.(3) Many additional units are operating around the world, especially in Japan. By the end of 1976, 333 Japanese units will be scrubbing a total of about 24,000 megawatts.(4) The large number of units operating and under construction around the world, employing many different processes and designed by many reputable manufacturers, offers strong evidence of technical feasibility. Three United States units (Paddy's Run, LaCygne, and Cholla) exemplify the state of the art and are discussed below.

Paddy's Run is operated by Louisville Gas and Electric at Louisville, Kentucky. This small 65 megawatt unit burns coal containing 3.5-4.0 percent sulfur. A lime scrubber designed by Combustion Engineering was retrofitted in April 1973. This station is operated only during peak power demands. The FGD unit is easily shutdown and restarted and has accumulated about one year of total operating time. The unit operates with an SO_2 removal efficiency of about 90 percent and has an availability record of 100 percent.

The LaCygne Station is operated by Kansas City Power and Light near Kansas City, Missouri. This large 820 megawatt unit burns coal containing 5.2 percent sulfur. A limestone scrubber designed by Babcock and Wilcox was retrofitted in February 1973. Overall, the operating experience has been encouraging. Over the two years from January 1974 through December 1975 all seven modules were operational; the availabilities of modules A through G were respectively, 79, 80, 75, 81, 79, 84, and 83 percent; the average for all seven modules was 80 percent. The SO_2 removal efficiency is about 80 percent.

The Cholla Station is operated by Arizona Public Service near Joseph City, Arizona. This medium size 115 megawatt unit burns coal containing 0.44-1.0 percent sulfur. A Research Cottrell designed limestone scrubber was retrofitted in October 1973. Only one of the two scrubber modules has been packed with corrugated plastic sheets, pending a final design determination for the packing. Module A(the packed unit) has as SO_2 removal efficiency of about 90 percent; the unpacked Module B is significantly lower. The entire system has a good record of reliability. For the two year period January 1974 to December 1975 the availabilities have been 90 percent (Module A) and 87 percent (Module B). Plant records shows that about 30 manhours per day are required for maintenance.

Lime and limestone FGD systems produce large amounts of calcium sulfite and calcium sulfate sludge. Disposing of the sludge requires proper treatment to prevent land degradation and groundwater pollution. Processes have been developed to fixate (harden) the sludge to an earthlike consistency, and are now offered commercially by several companies.

The experience with sludge treatment processes has been limited. Most utilities have chosen to dispose of the sludge untreated, along with the bottom ash and collected fly ash from the boilers. Duquesne Light, however, has conducted a full scale sludge treatment operation at its Phillips Power Station for about two years. Using the Dravo Corporation process, the sludge is mixed with a proprietary hardening additive and allowed to set in temporary on-site holding ponds. The sludge is then excarated and hauled to a permanent disposal site which has long been used for ash disposal. The sludge piles are firm enough to support bulldozers working on top of the piles. As the area is filled in, it is covered with earth and grass is now growing on some areas. This operation has been important in demonstrating that scrubber sludge can be disposed of in an acceptable manner.

The new Bruce Mansfield Power Plant of the Pennsylvania Power Company has provided for an elaborate sludge treatment operation. The disposal area is several miles from the plant in a large ravine closed in with a large dam. The sludge will be mixed with a hardening additive and pumped through pipes to the ravine. The entire operation will be managed by Dravo Corporation.

Many new types of scrubbers are being developed or operated. These second generation scrubbers offer improved SO_2 removal efficiencies and, in some cases, near elimination of solid waste. Three systems especially (Wellman-Lord, Double Alkali, and Chiyoda) are now ready for commercial installation.

The Wellman-Lord System is a process for scrubbing with a solution of sodium sulfite. The scrubbing solution is regenerated by heating, and a concentrated SO_2 stream is evolved. The SO_2 stream is further processed to an end product of elemental sulfur, sulfuric acid, or liquid SO_2. The advantages of this system are high SO_2 removal efficiency and no significant solid waste.

Seventeen full scale Wellman-Lord units are now operating in the United States and Japan. They are installed on sulfuric acid plants, Claus plants, and oil-fired power plants. The prototype installation on a small coal-fired plant is due to startup in mid-1976 at the Indiana Public Service Company's Mitchell Station near Gary, Indiana. Double alkali systems are so named because they use two alkalis, a reactive alkali such as sodium sulfite for scrubbing and an inexpensive alkali such as limestone for regenerating the first alkali. The advantage of double alkali systems are high SO_2 removal efficiency and lower scaling potential.

Double alkali systems have undergone extensive development and are now operational on many coal and oil fired industrial boilers and one Japanese oil fired boiler.(5) In order to demonstrate their applicability to coal-fired power plants, EPA is co-funding with Louisville Gas and Electric the installation of a double alkali system on a large 277 megawatt unit at Cane Run.

Chiyoda systems use dilute sulfuric acid as a scrubbing medium. The SO_2 dissolves and forms sulfurous acid. The used scrubbing liquor is regenerated in an oxidizing tower by adding ferric sulfate as a catalyst and sparging with air to convert sulfurous acid to sulfuric acid. To maintain the scrubbing liquor at a 2 percent acid level, a bleed stream is neutralized with limestone, producing an end product of calcium sulfate (gypsum).

The Chiyoda system was developed in Japan and is now operating on 13 boilers in that country. According to Chiyoda reports(6) the systems installed to date have established an impressive track record. The installed systems reportedly have accumulated a total of 20 years operating experience with an availability record of 94-100 percent. SO_2 removal efficiency is reported to be over 90 percent. The first United States installation was at Gulf Power Company's Scholz Plant in Florida. This is a small 23 megawatt demonstration unit that shows the system can operate successfully on a coal-fired power plant.(7)

The Tennessee Valley Authority (TVA) has made an extensive study of the costs of lime, limestone, and Wellman-Lord systems.(8) The Results are reproduced in part in table 4. As shown, the costs depend on many factors, including plant size, plant age, fuel type, sulfur content, and new versus retrofit installations.

The actual costs of FGD systems can vary significatnly from the TVA estimates because of site specific factors such as terrain conditions, difficulty of retrofit, redundancy of equipment, etc. A recent survey of 19 lime and limestone systems installed, constructed, or planned, showed that capital costs ranged from 34 to 116 dollars per kilowatt.(9) When the costs were adjusted to a common basis the range narrowed to 50-88 dollars per kilowatt with an average of 70 dollars per kilowatt. The adjusted costs are therefore in good agreement with TVA's estimated costs for model plants.

Table 4. Total Capital Investment Requirements and Total Average Operating Costs of Lime, Limestone, and Wellman-Lord Systems (Reproduced in part from TVA cost study. (8)

Case	Years Life	Limestone		Lime		Wellman-Lord	
		$/KW	Mills/KWh	$/KW	Mills/KWh	$/KW	Mills/KWh
Coal-fired power unit 90% SO_2 removal; onsite solids disposal							
200 MW, new 3.5% S	30	88.4	4.20	79.9	4.54	112.0	6.60
200 MW, existing, 3.5% S	20	76.4	4.06	87.6	5.11	118.0	7.76
500 MW, existing, 3.5% S	25	62.2	3.39	70.0	4.15	86.7	6.34
500 MW, new, 2.0% S	30	61.5	3.04	55.1	3.18	73.6	4.16
500 MW, new, 3.5% S	30	68.4	3.41	61.1	3.65	84.8	5.37
500 MW, new, 5.0% S	30	74.2	3.74	66.3	4.11	94.4	6.53
1,000 MW, existing, 0.5% S	25	47.5	2.82	51.6	3.40	67.0	5.54
1,000 MW, new, .5% S	30	51.4	2.74	44.9	2.94	64.2	4.46
80% SO_2 removal; insite solids disposal							
500 MW, new, 3.5% S	30	65.9	3.23	58.9	3.49	80.8	4.98
90% SO_2 removal; onsite solids disposal (existing unit without existing particulate collection facilities)							
500 MW, existing, 3.5% S	25	80.6	4.11	70.2	4.24	104.8	7.14
Oil-fired power unit 90% SO_2 removal; onsite solids disposal							
200 MW, new, 2.5% S	30	56.4	3.02	64.5	3.66	71.7	4.62
500 MW, new, 1.0% S	30	35.6	2.11	43.5	2.55	42.0	2.55
500 MW, new, 2.5% S	30	42.4	2.44	49.6	3.02	53.0	3.74
500 MW, new, 4.0% S	30	47.8	2.73	54.3	3.40	61.9	4.87
500 MW, existing, 2.5% S	25	50.4	2.85	58.7	3.47	67.2	4.38
1,000 MW, new, 2.5% S	30	32.9	1.90	36.2	2.45	40.6	3.17

There is little published information on double-alkali systems. EPA estimates the capital costs to be 50-60 dollars per kilowatt and the operating costs to be 2.5-3 mills per kilowatt-hour.(10)

Chiyoda International Corporation estimates that the system's capital cost is about 76 dollars per kilowatt.

Sludge treatment costs are in addition to the above estimates. Aerospace Corporation has studied these costs. Estimates were obtained from three principal firms that offer commercial processes; Chemfix, Dravo, and I.U. Conversion Systems. The figures were adjusted to a common basis, including capital investment, additives, labor, processing, and transportation of sludge 5 miles to the disposal site. The operating costs came to 0.9 to 1.4 mills per kilowatt hour.(11)

Table 5 summarizes the approximate costs for FGD systems. As shown, the operating costs are about 5.5 mills per kilowatt-hour. The average cost of electric power to residential consumers is about 35 mills per kilowatt hour. The FGD System costs, therefore, increase residential power costs about 15 percent if one assumes that all units in a power system were to install FGD systems. Of course, this is not the case with EPA's Ohio regulations; thus overall residential power costs are expected to be substancially less than 15 percent state-wide.

Table 5. Approximate Cost of FGD Systems

System	Capital Cost $/KW	Annual Cost mills/kw-hr
Limestone (a)	70	5.5
Lime (a)	60	5.5
Wellman-Lord	85	3.5
Double Alkali (a)	55	6.5
Chiyoda	76	---

(a) Annual costs include 1.5 mills per kilowatt-hour for sludge fixation.

2. Industrial Boilers

Industrial boilers are used to produce steam for a variety of industrial processes. They are very similar to their counterparts in the utility industry, but are usually much smaller. Many industrial boilers burn coal or oil and therefore emit SO_2 as a combustion product.

Sulfur dioxide control alternatives are the same as for utility boilers; low sulfur fuel, coal washing, and FGD equipment. As with utility boilers, the low sulfur fuel and FGD alternatives are capable of meeting the most stringent regulations in Ohio. The allowable sulfur content for a range of emission standards is shown in Table 1 (Section V.C.1.) for coal and Table 2 (Section V.C.1.) for oil In some cases, depending on the emission limitation and the pyrite fraction of the coal sulfur, coal washing will be adequate to meet the standards.

In the last few years, FGD installations have appeared on industrial boilers throughout the country. Under contract with EPA, PEDCo Environmental Specialists is preparing a summary of these units. The current list of operational units is shown in Table 1. The FGD systems range from a small 10,000 actual cubic feet per minute (acfm) unit to 700,000 acfm. For comparison, a small 100 MW utility boiler will produce about 500,000 acfm of combustion gases.

EPA has commissioned studies on three representative industrial boilers.

Table 1. Operational FGD Systems on Industrial Boilers

Company & Location	Size ACFM	Fuel	Sulfur &	Supplier	Type
Caterpillar Tractor Joliet, Illinois	90,000	Coal		Zurn	Double-Alkali
Caterpillar Tractor Mapleton, Illinois	360,000	Coal	3.2	FMC	Double-Alkali
Caterpillar Tractor Mossville, Illinois	240,000	Coal	3.2	FMC	Double-Alkali
Canton Textiles Canton, Georgia	42,000	Bark & Coal	3.0	FMC	Na_2CO_3
Firestone Tire & Rubber Pottsdown, Pennsylvania	10,000	Oil, or Coal	high high	FMC	Double-Alkali
FMC Modesto, California	30,000	Oil	high	FMC	Double-Alkali
FMC Greenriver Wyoming	350,000	Coal	1.3	FMC	Na_2CO_3
General Motors Parma, Ohio	160,000	Coal	2.5	G.M.	Double-Alkali
General Motors St. Louis, Missouri	125,000	Coal	3.2	CEA	NaOH
General Motors Tonowana, New York	160,000	Coal	1-1.5	FMC	NaOH

Table 1. (Con't) Operational FGD Systems on Industrial Boilers

Company & Location	Size ACFM	Fuel	Sulfur %	Supplier	Type
General Motors Dayton, Ohio	60,000	Coal	1-1.5	FMC	NaOH
Transco Textiles Augusta, Georgia	50,000	Oil	2	FMC	NaOH
Commercial Fabricating & Machine Mt. Airy North Carolin		Oil	2.6	Air Pollution Industries	NaOH
ITT Rayonier Fernandino Beach, Fla.	400,000	Coal, Oil, or Bark	2.5-2.8	Air Pollution Industries	NaOH
Great Southern Paper Cedar Springs, Georgia	700,000	Coal, Oil, or Bark	1.5 1.5	Air Pollution Industries	NaOH
Georgia Pacific Crossett, Arkansas	320,000	Coal Bark		Air Pollution Industries	NaOH

Table 1. (Con't) Operational FGD Systems on Industrial Boilers

Company & Location	Size ACEM	Fuel	Sulfur %	Supplier	Type
St. Regis Paper Pensacola	170,000	Oil Bark		Air Pollution Industries	NaOH
Nekoosa-Edwards Ashtown Arkansas	300,000	Bark	1.0	Air Pollution Industries	NaOH
U.S. Gypsum Oakmont Pennsylvania	175,000	Coal		Air Pollution Industries	Double-Alkali
Mead Stevensville Alabama		Oil	1.5-3.0	Air Pollution Industries	Na_2CO_3
Finch Pryun Glen Falls New York		Black Liquor		CEA	NH_4OH

These are: PPG Industries Incorporated, Barberton Plant(12); Mead Corporation, Chillicothe Mill(13); and Union Camp Corporation, Dover Plant(14). Manufacturers of control equipment were asked to estimate the cost of their equipment, and from this information total capital costs were computed. The total annual operating cost was derived by amortizing the capital cost and adding in labor, overhead, utilities, materials, waste disposal, taxes, and by-product recovery credit. The results are summarized in Table 2.

The plants chosen for study are representative of large, medium, and small size industrial boilers. The large PPG plant operates 8 separate boilers for production of steam and electricity by burning 4.3 percent sulfur coal. The model FGD unit was sized to service the design effluent for the combined gases from all boilers. This plant produces chlorine, caustic soda, hydrogen peroxide, and silica pigments.

The Mead Mill produces pulp and paper, and burns 4.3 percent sulfur coal in a medium size boiler to produce process steam for heating. Since limestone systems smaller than 130,000 scfm are not currently available, cost data were not available. Manufacturers of lime, Wellman-Lord, and double alkali systems were contacted, but only lime system costs were provided.

The Union Camp Plant produces fatty organic chemicals. Two small boilers burning 3.4 percent sulfur coal generate process steam. Lime and double-alkali systems were evaluated.

Table 2. Total Capital Costs and Total Annual Operating Costs for SO_2 Controls at Representative Plants in Ohio.

		Millions of Dollars				
		Lime	Wellman-Lord	Lime-stone	Double-Alkali	Low-Sulfur Coal (incremental cost)
PPG Industries Barberton Plant 2710 x 10^6 BTU/hr 710,000 scfm (a)	Capital	20.5	34.4	19.8	17.4	2.5
	Annual	9.3	7.8	8.1	8.0	4.5-6.5
Mead Corporation Chillicothe Mill 1207 x 10^6 BTU/hr 334,000 scfm (b)	Capital	4.3				
	Annual	1.6				0.79-1.4
Union Camp Dover Plant 112 x 10^6 BTU/hr 57,000 scfm (c)	Capital	1.8			1.9	
	Annual	0.6			0.60	0.024-0.046

(a) Design rate for the combined effluent from all eight boilers; FGD systems are designed for this rate.

(b) Design rate for the combined effluent from all three boilers. FGD systems were designed for only 114,000 scfm; the rest could be bypassed.

(c) Design rate for he combined effluent from both boilers. FGD systems were designed for only 33,000 scfm; the rest could be bypassed.

References for C. Control Technology Capability of Fossil Fuel Fired Steam Generators.

1. APTD-0711, Background Information for Proposed New Source Performance Standards - Steam Generators, Incinerators, Portland Concrete Plants, Sulfuric Acid Plants.

2. An Evaluation of Low Sulfur Fuel Availability for Use in Ohio Power Plants to Meet SO_2 Regulations; Foster Associates, January 1974. EPA Contract No. 68-02-1076.

3. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by Devitt, et. al. at Table 1,page 15.

4. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by Ando, at Table 5, page 59.

5. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by Kaplan at pages 418-419.

6. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by Dakan at Table 1, page 763.

7. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by Dakan.

8. EPA-600/2-76-136a. Proceedings: Symposium on Flue Gas Desulfurization New Orleans, March 1976; paper presented by McGlamery et. al., at Tables 1,2 pages 84-85.

9. "Estimating Costs of Flue Gas Desulfurization Systems for Utility Boilers", Devitt et. al., J. of the Air Pollution Control Association, Volume 26, page 204 ff (March 1976).

10. EPA-600/2-76-136a, op. cit., paper presented by Kaplan at page 416.

11. EPA-600/2-76-070. Disposal of Flue Gas cleaning wastes: EPA Shawnee Field Evaluation. Initial Report (March 1976) at 109.

12. "Evaluation of the Technological Feasibility, and Cost of Selected Control Alternatives Necessary to Meet the Proposed Ohio SO_2 Regulations for Industrial Boilers and Processes," Volume II, GCA Corporation Report, June 1976, EPA Contract 68-01-3155.

13. "Evaluation of the Technological Feasibility, and Cost of Selected Control Alternatives Necessary to Meet the Proposed Ohio SO_2 Regulations for Industrial Boilers and Processes, "Volume VI, GCA Corporation Report, July 1976, EPA Contract 68-01-3155.

14. "Evaluation of the Technological Feasibility, and Cost of Selected Control Alternatives Necessary to Meet the Proposed Ohio SO_2 Regulations for Industrial Boilers and Processes," Volume IX, GCA Corporation Report, July 1976, EPA Contract 68-01-3155.

D. General Industrial Processes

The preceding subsections have dealt with the most common SO_2 sources in Ohio. It is unnecessary to consider every source type, because the scrubbers described above are generally applicable to any source.

The scrubber's contact with the controlled source is limited to the exhaust gas. Scrubbers do not affect the upstream process except by forcing shutdowns when the scrubber malfunctions. Such shutdowns can be prevented by installing bypasses around the scrubber. With this design, the controlled source and the scrubber will operate independently.

Nearly any exhaust gas can be cleaned in a wet scrubber. If pretreatment is needed, the gas can be cooled with air or water sprays; also, particulates can be removed in mechanical on electrostatic dust collectors. Available construction materials can withstand the corrosion and erosion of almost all industrial exhaust gases. If, in a given situation, an exhaust gas is too reactive to put through a scrubber, it is doubtful that the gas should be allowed to enter the atmosphere.

As discussed above, most scrubbers operate with SO_2 removal efficiencies of approximatly 90 percent. As far as known, 90 percent removal is adequate for most Ohio sources subject to the industrial process regulations.

As an example of the application of the proposed process regulations, (the final regulation, 5.45 lbs. SO_2 per ton of process weight represents "status-quo"), EPA commissioned a contract study of the Phillips Petroleum carbon black manufacturing plant in Toledo Ohio(1). In this process, carbon black particles are formed by partial combustion of oil, and then separated from the combustion gases. The gases are collected and used as fuel in driers and boilers; unused gases are burned in an incinerator. The exhaust gasses from the driers and incinerator were subject to the general process regulation ($Ep=19.5p^{0.67}$) and the boilers (not discussed) were subject to a separate standard.

The contractor concluded that the proposed general process regulation could be met either by limiting the feed oil to 1.2 percent sulfur or less, or by installing a small lime FGD system. (The contractors study is available for review at Region V.) In the latter case, the gases from the driers, incinerators, and boilers would be combined for economical treatment. Only a portion of the combined stream would need cleaning, with the remainder being bypassed and used for reheat. The total capital cost was estimated at 1.92 million dollars; total annual operating cost came to 580 thousand dollars. The total operating cost is equivalent to 0.88 cents per pound of carbon black produced, which compares to a typical carbon black selling price of 12 cents per pound.

A study was also done on Union Carbide's activated carbon plant at Fostoria.(2) In this process, coal or coke is mixed with elemental sulfur plus a binding agent. The mix is made into pellets and calcined in a gas-fired furnace. The feed to the calciner contains 10 to 20 percent sulfur and 50 to 80 percent is driven off. The off gas is incinerated and discharged from a stack.

The promulgated Ohio standards require the above plant to cut back approximatly 22% on its current SO_2 emissions. The contractor's analysis, however, which addressed the more stringent proposed industrial process regulation, indicates that the proposed regulation could be met with a lime scrubber. The analysis is of interest because the high sulfur content of the feed (10 to 20 percent) makes this a severe example of technical feasibility.

The plant could meet the most stringent process regulation with a scrubber with a removal efficiency of 97 percent. Lime, double alkali, and Wellman-Lord scrubbers can be engineered for efficiencies this high. If a lime system is chosen, the contract study estimates the total capital cost would be 2.3 million dollars. Total annual operating cost would be 918 thousand dollars. The costs are equivalent to 0.072 dollars per pound of activated carbon produced, compared to a selling price of 43 cents to $1.65 per pound.

References

1. "Evaluation of the Technological Feasibility, and Cost of Selected Control Alternatives Necessary to Meet the Proposed Ohio SO_2 Regulations For Industrial Boilers and Processes," Volume V, GCA Corporation Report, July 1976, EPA Contract 68-01-3155.

2. "Evaluation of the Technological Feasibility, and Cost of Selected Control Alternatives Necessary to Meet the Proposed Ohio SO_2 Regulations For Industrial Boilers and Processes," Volume VIII, GCA Corporation Report, July 1976, EPA Contract 68-01-3155.

E. Availability of Low Sulfur Coal for Ohio Utilities

Compliance with the proposed Ohio sulfur oxide regulation can presently be achieved by either of two methods. The flue gas generated by the burning coal in a utility's boiler can be cleansed by a flue gas desulfurization system or the coal used in the boiler can be of such quality that the anticipated flue gas contains less sulfur dioxide than the emission standard permits. Utilities that employ this latter approach burn "conforming" fuel.

For the coal-fired plants in Ohio, available data indicate that conforming coal is present in sufficient quantities in the coal reserves of Ohio and the surrounding states to meet the projected needs of the Ohio utilities. A possible exception would be coals with an average sulfur content equivalent to or less than 0.9 lbs. SO_2/MMBtu. Also, unknown quantities of the Eastern low sulfur coal reserves are owned or controlled by non-utility companies and may not be available for use in Ohio utility plants. It is not certain how much of these reserves are economically recoverable at current prices.

While the best possible option available to some Ohio utilities could be the use of Ohio coals in combination with FGD systems to meet the proposed regulation, we evaluated the availability of low sulfur coals by making the hypothetical assumption that all coal-fired plants will opt for using conforming coal. The average sulfur content of coals was used in determining compliance with the proposed Ohio regulations. This introduces a certain amount of error in the analysis where the range of sulfur in coal is great given that the power plant must burn conforming fuel each and every day. The potential impact of coal sulfur variability is not discussed in this analysis.

Reserves

Two recent publications by the United States Bureau of Mines (The Reserve Base of U.S. Coals by Sulfur Content, Parts 1 and 2, Information Circulars 8680 and 8693) estimate remaining coal reserves as of January 1, 1974. Estimates were made state by state and listed by sulfur content. For the United States as a whole, the reports estimate that 200 billion, 100 million tons of coal have a sulfur content of 1% or less, and 28 billion, 823 million tons have a sulfur content of 1.1 - 1.4%. This agrees fairly well with a study entitled "The Economy, Energy and the Environment" prepared by the Library of Congress, Legislative Reference Service, Environmental Policy Division, which estimates a 1% or less sulfur reserve of 215 billion, 97.3 million tons, and a 1.1 - 1.5% sulfur reserve of 49 billion, 125 million tons. Further, the Bureau of Mines figures show Ohio reserves of 0.6% or less to be 12 million, and reserves in the 0.7 - 1.0% and the 1.1 - 1.4% sulfur range to be 123 million and 360 million. The states bordering Ohio (Pennsylvania, West Virginia, Kentucky, Indiana and Michigan) are estimated to have 5 billion, 400 million tons of 0.6% or less sulfur, 16 billion, 530 million tons of 0.7 - 1.0% sulfur and 8 billion, 730 million tons of 1.1 - 1.4% sulfur coal. Thus, while Ohio has limited amounts of low sulfur coals, the surrounding states contain approximately 5% of the total U. S. reserves of 0.6% or less sulfur bituminous and sub-bituminous coals. These states also contain 16 billion, 530 million tons or 26% and 8 billion, 730 million tons or 38% of the U. S. reserves of 0.7 - 1.0% and 1.1 - 1.4% sulfur coal.

As a rule of thumb, one-half of these estimated reserves of bituminous and sub-bituminous coals are considered to be recoverable. Therefore, the recoverable U.S. total of 0.6% or less sulfur coal is 59 billion, 790 million tons and the recoverable U. S. total of 0.7 - 1.0% and 1.1 - 1.4% sulfur coal is 31 billion, 290 million and 11 billion, 450 million tons. The corresponding totals for Ohio and the surrounding states are 2,700 million, 8,260 million and 4,370 million tons respectively.

Selective reserve data is included in Table 1.

Production

In 1974, 45.4 million tons of coal were mined in Ohio. The bulk of this tonnage is greater than 1% sulfur and is normally considered to be high sulfur coal.

However, significant tonnages of low sulfur coal (1% or less) are mined in the states surrounding Ohio. In 1973, 61.3 million tons of 1% or less sulfur coal was mined in West Virginia. This tonnage is equivalent to 53% of the state's total production for that year, and is compiled from the Annual Report, State of West Virginia, Department of Mines, Directory of Mines, 1973(2). Compilations of production by sulfur content for later years are not available, however, estimates can be made from

Table 1. Coal Reserve Estimates as of January 1, 1974
(Million Tons)

	Percent Sulfur, by Weight							Total.
	0.6 or less	0.7-1.0	7.1-1.7	1.5-1.8	1.9-2.2	2.3-2.6	2.7 or greater	
Ohio	12	123	360	786	1,147	1,725	16,928	21,081
Pennsylvania	134	903	2,071	3,420	4,202	4,063	9,073	23,866
W. Virginia	3,996	10,096	4,277	2,878	2,674	2,250	13,402	39,573
Kentucky	1,254	5,304	1,817	667	396	393	15,701	25,532
Indiana	0	98	192	626	404	504	8,800	10,624
Michigan	0	5	14	19	19	16	45	118
Eastern U.S.	6,234	18,866	10,824	10,465	10,947	11,105	125,547	193,988
Western U.S.	113,354	43,705	12,072	5,091	3,447	1,270	28,225	207,164
U.S. Total	119,588	62,571	22,896	15,556	14,394	12,375	153,772	401,152

Source: U.S. Bureau of Mines Information Circular 8680 and 8693, 1975 total state production figures using an approximation of 50% for the low-sulfur coal production. This procedure would lead to estimates for 1974 and 1975 of 50.9 and 55 million tons respectively of 1% or less sulfur coal. Total production for 1974 is reported by the West Virginia Department of Mines to be 101,713,590 tons. Total West Virginia production in 1975 is estimated by the Keystone News Bulletin to be 110 million tons(3). The bulk of the 85.4 million tons of coal mined in Eastern Kentucky is also considered to be low sulfur coal (1.4% or less). Coals produced in Eastern Kentucky and West Virginia provide much of the low sulfur coals burned in Eastern and Mid-Western utility power plants.

The National Coal Association's forecast for 1975 projected a 7.6 percent annual increase in U.S. coal production from 590 million tons in 1974 to 635 million tons in 1975. It now appears that this projection may have fallen short by as much as 11 million tons. According to Coal Age magazine (February 1976, Page 82) and Coal Week (January 5, 1976, Page 5) this will result in an excess production of 12 - 14 million tons of coal for 1975. The National Coal Association's projected 1976 production is 664 million tons.

In order to present a more detailed and comprehensive picture of low sulfur coal production, a number of items are reference. Included in the referenced document are figures for number of mines, coal production, coal employment by method of mining and a map which indicates coal production tonnage ranges for each county. Reference 4 contains a list of companies in Appalachian states bordering Ohio producing coal from low sulfur seams in 1973 and an analysis of 1973 production from each low sulfur seam including name of company, name and location of mine, days worked, number of employees and type of mine. Reference 5 shows captive coal production for the year 1975, by industries, and lists the organizations owning and/or controlling major coal-producing companies in the United States.

With the possible exception of the very low sulfur coals (less than 0.6% S), finding coal in Appalachia with the proper level of sulfur content does not present a serious problem from the standpoint of reserves of ultimate availability. The foregoing production data indicate that there is a substantial amount of existing capacity in this area and, as discussed below, other information indicates that this capacity was and is presently available.

Short-Term Availability

A survey by the Energy Division of Foster Associates, Inc. in February 1975, indicates that a substantial surplus capacity existed. This applied to low sulfur areas since a significant amount of spot purchasing was performed there. The reason given for this surplus capacity were: 1) the failure of 1974 coal consumption to reach the levels which had been forecast; 2) the depressed steel demand caused by the recession had in turn reduced demand for marginal coking coal. Their opinion was that 2 to 3 million tons of conforming coal could be forthcoming by

June 1975(6). Foster's opinion on surplus capacity was reaffirmed March 8, 1976(7), and the estimate of conforming coal from Eastern Kentucky and West Virginia that could be placed under contract was increased to 5 million tons. This assumes that price would not impose a serious constraint. Foster also conducted an analysis of the availability of conforming coals for use in Ohio power plants to meet the proposed regulations(8). Foster indicated power plants would have a difficult time obtaining coals with a sulfur content of less than 0.6% and extreme difficulty in obtaining coals with a sulfur content of less than 0.4%. It is noted that the Ohio SO_2 requirements do not mandate coals with these very low sulfur contents in any area.

According to a January 1975 report by the Coal Supply Potential Task Group(9) supply should, in general, be available during the short run period from 1975-77. "The capacity exists in the East to produce at least 30 million tons above projected consumption and a reduced rate of inventory rebuilding could be tolerated by the end of 1975. The surge capacity estimate is supported by industrial claims and by historical evidence. In the first half of 1974 an increase in production over a similar period in 1973 of 18 million tons was achieved (similarly, the first half of 1975 showed a 9.5 million tons increase over the same period in 1974). This was in response to higher prices which encouraged increased operation of marginal mines, use of overtime, and more costly labor sources (such as new and inexperienced miners).

Though new mines cannot be opened quickly, production from existing mines, mainly surface mines, can be increased by purchasing additional machinery. Strip mines (mines on 20° slopes or greater) in Appalachia, which produce about 75 million tons per year can use equipment which is readily available by purchase from the construction industry and in 12-18 months for new equipment. These mines can respond rapidly to price increase by increasing production to the extent of 20 million tons per year or more.(9) Although substantial quantities of the new Eastern output can be expected to be medium sulfur (1.0-2.0% sulfur) coal, a great deal of this can be used to meet certain requirements in the Ohio SO_2 plan or washed down to conforming levels of sulfur content.

The availability of low sulfur coal is underscored by the recent public testimony of a C & O Railroad official. John Hanifin, President and Chief Executive Officer of C & O testified before the Senate Public Works Committee on June 11, 1975. Referring to a survey of 41 mines completed by C & O on June 5, 1975, he pointed out that the capacity to produce 30,000 tons per day of 1% or less sulfur coal was not in use due to a lack of orders. This amounted to 3.6 million additional tons of low sulfur coal which could have been produced from January through May, 1975(10).

A February 1974 paper prepared on behalf of the West Virginia Legislature(11), contends that "The statement that West Virginia coal is not available is not true if examined carefully. West Virginia coal owners generally need long-term contracts (3 years or more) at a proper price (from $6 to $25 per ton depending on quality) to allow for financing of new or expanded mine operations. While some low sulfur West Virginia coal can be obtained on the open market today, an interested utility will usually have to make an attractive offer to West Virginia producers to obtain a positive response from them. Offers to low-sulfur producers at high-sulfur prices will not be helpful; nor will contract offers to high sulfur producers for a year or so, depending on temporary waiving of sulfur standards. Long-term commitments for West Virginia coal likely can be arranged if serious offers are made for this coal . . . ."

New Capacity

It appears obvious that new coal mine capacity will have to be developed in order to satisfy increasing long-term demands. Some new capacity can be developed by adding another production shift at those mines which only operate one shift. However, long-term increases in production capacity will have to result from the opening of new mines. New coal mine capacity in the State of West Virginia as of 1973 was planned to increase by over 33 million tons from 1973 through 1979. Similar data in 1975 show a planned increase of 46.3 million tons from 1975 through 1979. Some of this new capacity has already been realized, while over a quarter of the total planned increase is scheduled to come on stream during 1976(12). The new mine capacity for eastern Kentucky is projected to increase by 37.6 million tons from 1975 through 1985 with approximately 20 million tons being developed by American Electric Power (AEP). Table 3 of Reference 12 shows planned coal mine expansions by state and year. Table 4 of Reference 12 lists the probable application of the additional coal, and Table 5 of Reference 12 shows company and mine name, location, mine type, coal users, capacities and years.

Consumption

The 1974 fuel purchases of operating Ohio utility power plants were used to project power plants coal needs for 1976 through 1985. The fuel needs of new plants were included in this estimate. Table 2 compares, for different coal sulfur ranges, projected utility power plant fuel needs through 1985 with bituminous and sub-bituminous coal reserve estimates for the states surrounding Ohio, the Eastern and Western states and the total United States.

Compliance with the originally proposed regulations through the use of low sulfur coal requires the Philo, Beckjord, Tidd and Sammis Plants to burn coals from 0.3% sulfur to less than 0.6% sulfur. Plants that would require approximately 0.6% sulfur coals for compliance with the proposed regulations are Avon Lake, Eastlake, Cardinal, Burger, Ashtabula, Miami Fort, Killen Station, Conesville and Poston. The use of low sulfur coal would require, through 1985, the commitment of 3% of coal reserves of

Table 2. Comparison of Projected Ohio Utility Coal Needs With Coal Reserves

Sulfur Range	Projected Ohio Coal Needs 1976-1985	Coal Reserves (MM Tons)				
		Ohio and Surrounding States	Eastern U.S.	Western U.S.		Total U.S.
(Percent)	(NM Tons)		Bituminous	Bituminous	Sub-Bituminous	
0.6	165	5,396	6,234	6,691	106,663	119,588
0.7-1.0	100	16,529	18,866	4,507	39,198	62,571
1.1-1.4	83	8,731	10,824	2,636	9,436	22,896
1.5-1.8	42	8,396	10,465	1,389	3,702	15,556
1.9-2.2	26	8,842	10,947	991	2,456	14,394
2.3-2.6	41	8,951	11,105	827	443	12,375
2.7	4	63,919	125,547	21,812	6,413	153,772
Total	461	120,764	193,988	38,853	168,311	401,152

0.6% sulfur or less in Ohio and the surrounding states, and 2.5% of the coal reserves in the Eastern U. S., Toronto, Eastlake (4), Lake Shore, Avon Lake (11), Acme, Miami Fort (4-1 and 4-2), Eastlake (1, 2, and 3), Niles, Woodcock, Bay Shore and Painesville must burn low sulfur coals ranging from 0.7% to 1.0 sulfur for compliance with the proposed Ohio sulfur dioxide regulation. These plants require a commitment of approximately 0.6% of 0.7 to 1.0% sulfur coal in Ohio and the surrounding states and approximately 0.2% of the U. S. reserves for this sulfur range. Approximately 0.9% of the nearby 1.1 to 1.4% sulfur coal reserves would be required for the Tait, Hamilton, Hutchings, Avon Lake (9-10), Edgewater, Lake Shore (93-94), Acme, Stuart and Gorge to attain compliance with the proposed regulation by burning low sulfur coals. The promulgated regulations, which are somewhat less stringent that the proposed regulations, would result in a lesser demand on the low (.3 to .6%) sulfur coals. For example, of the thirteen plants listed above in this category, only six facilities (Avon Lake, East Lake, Philo, Killen Station (NSPS only), Miami Fort (NSPS only), and Poston (NSPS only)) would remain, and in three instances NSPS and not the promulgated regulation is the dominant factor.

Coal Costs

The delivered prices of 1975 coal purchases by utility power plants in Ohio and the surrounding states are presented in Table 3(14). The price differences between the low and higher sulfur coals burned by Ohio power plants have diminished. This is

Table 3. 1975 Delivered Prices of Coal by Sulfur Content to Utility Plants in Ohio and Surrounding States (Cents/MMBtu)

State	Percent Sulfur, by Weight						Average
	0.5	0.51-1.0	1.01-1.5	1.51-2.0	2.01-3.0	3.01	
Ohio	99.4	113.7	118.5	119.5	91.6	89.8	95.2
Pennsylvania	53.5	124.4	96.3	98.1	91.9	101.0	95.5
West Virginia	129.8	101.5	113.4	93.7	78.9	55.3	87.2
Kentucky	66.3	77.5	89.7	87.0	73.9	56.8	64.2
Indiana	80.9	91.6	82.9	58.9	58.0	53.4	59.2
Michigan	86.8	114.4	110.8	107.9	83.6	88.0	92.3

Source: Annual Summary of Cost and Quality of Steam-Electric Plant Fuels, 1975, Staff Report by the Bureau of Power, Federal Power Commission, May 1976 indicative of price trends reported by Coal Week and other coal related publications of reductions in utility coal prices and particularly the reduction in the cost of low sulfur coals. Coal prices reported in the June 7, 1976 Coal Week (data obtained from the McGraw-Hill report entitled "Fuel Price Analyses") indicated the price of low sulfur coal of one percent sulfur or less (74.7¢/million Btu) was less than the price of the higher sulfur coals (84.8¢/million Btu). Also, the spot market price of low sulfur steam coal from Districts 7 and 8 appear to be less than the higher sulfur and lower Btu Ohio and Northern West Virginia coals(15).

Conclusions

When the projected Ohio utility coal needs are compared to the reserves of coal it is obvious that sufficient quantities of low sulfur conforming coals are available. However, Foster has reported that low sulfur coals with an average sulfur content of 0.9% may be difficult to obtain(8). And while it is possible that an instantaneous demand for large quantities of low sulfur coal might result in temporary shortages of conforming coal, it appears that a substantial portion of the coals needed by Ohio utility plants have been or can be procured.

For example, American Electric Power Company in its testimony and in recent publications indicated that they have or are developing large captive low sulfur coal mines in Southern West Virginia and eastern Kentucky. The company has also contracted for substantial quantities of Appalachian, Utah and other western low sulfur coals. Ohio Power Company stated in its testimony that the Gavin plant could blend low sulfur coal with Ohio coal from its Meigs Creek Mine complex to comply with the proposed regulations. The Cardinal plant of Ohio Power and Buckeye Power has contracted with the Valley Camp Coal Company for low sulfur coal. Dayton Power and Light recently entered into a contract with General Energy of Kansas City for low sulfur coals. These and other coal contracts should provide the Ohio utilities with a substantial portion of the required conforming coals.

References for Part E. Availability

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9. Coal Supply Potential Task Group Report - Utility Oil Savings Study, January 14, 1975.

10. Statement of John W. Hanifin, President & Chief Executive Officer of the Chesapeake & Ohio Railway Company and the Baltimore & Ohio Railroad Company relating to S. 1777 before the Senate Committee on Public Works, June 11, 1975.

11. West Virginia Coal as an Alternative to the Energy Crisis Presented to Citizen's Energy Conference, Washington, D.C. February 16, 1974 by Norman Kilpatrick, Research Analyst West Virginia Legislature.

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13. 1975 Delivered Prices of Coal by Sulfur Content to Utility Plants in Ohio & Surrounding States (Cents/MMBtu) from Annual Summary of Cost and Quality of Steam-Electric Plant Fuels, 1975, Staff Report by the Bureau of Power, Federal Power Commission, May 1976.

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15. Draft copy task order No. 6, Task Change No. 3, contract #68-02-1452 titled Availability of low Sulfur Fuel Oil in Ohio, prepared for the U.S. EPA by Energy Division, Foster Associates, Inc. Washington, D.C. June 30, 1976.

SECTION VI

AIR QUALITY MAINTENANCE REQUIREMENTS

Section VI. AIR QUALITY MAINTENANCE REQUIREMENTS

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SECTION VI. AIR QUALITY MAINTENANCE REQUIREMENTS

INTRODUCTION

The purpose of Section VII is twofold. First, to provide the EPA modeling staff with detailed indicators of the rate of SO_2 emission growth as a result of industrial and urban activity;(1) and second, to provide the citizens and industry of Ohio with an emission control regulation which results in the attainment of the National Ambient Air Quality Standard (NAAQS) and the provisions of a period of Standard Maintenance (the anticipation and prevention of future possible standard violations).

A. National Requirements for Maintenance of NAAQS

As a result of the NRDC v EPA (475 Fed 968 DC Cir 1973) suit, the Administrator determined that no State Implementation Plan contained all the measures necessary to ensure the maintenance of the standards and that no plan has adequately analysed the impact of growth on air quality maintenance for any period of time into the future. Accordingly, on March 8, 1973 (38 FR 6279), the Administrator disapproved all State plans with respect to maintenance of standards. (2)

On June 18, 1973, EPA promulgated revisions to 40 CFR 51.12, requiring States to identify by March 8, 1974, areas that may have potential for exceeding any NAAQS within the next ten year period (1975-1985).(2) This potential is judged by analysis of nt air quality, compliance data, and projected emission ch. Based on the States analysis, EPA was to publish by June 1974, a final list of potential problem areas, then referred as Air Quality Maintenance Areas or AQMAs, which were to be nalyzed by the State in greater detail with the cooperation of local or regional governments and planning commissions. The detailed analysis is to allow the State to identify the portions of the Air Quality Control Regions which require specific control strategies (Air Quality Maintenance Plans).

On May 8, 1974, EPA extended the date for the State AQMA identification to May 10, 1974. In accordance with the "Guidelines for Disignation of Air Quality Maintenance Areas", issued as Volume 1 to the 14 volume AQMA Guideline series, the States and EPA considered Standard Metropolitan Statistical Areas (SMSAs) as the broadest AQMA geographic area.(3) One or more public hearings on the identification of specific counties and pollutants occurred for each potential maintenance area. The Region V potential AQMA list for Ohio was published on August 12, 1974.(4)

The States and EPA analysis of air quality data and public hearing comments resulted in the April 29, June 2, and September 9, 1975, publication of final maintenance area designations. The final EPA designations for Ohio are listed in Table 1. Under the existing regulations, the States must reassess these area identifications at least every 5 years to determine whether additional areas should be considered as maintenance problem areas.(5) The Administrator believes that formal USEPA identification and designation in the future is no longer necessary, because the Act already has provisions for calling revisions to plans found substantially inadequate to attain and maintain the NAAQS.(6) Therefore, the Administrator proposed on October 20, 1975 (40 FR 49048), that 51(D) be revised to eliminate the need for future USEPA designated AQMAS. The May 3, 1976, Federal Register rulemaking action (41 FR 18382) finalized the maintenance area submission and format requirements.(7)

Table 1. OHIO AQMA DESIGNATIONS
JUNE 2, 1975 40 FR 23755

Name	Counties	Pollutant
Akron-Canton	Summit, Portage, Stark	TSP, SO_2
Cincinnati Interstate*	Hamilton, Warren, Bulter Clermont	TSP, Oxidant
Cleveland	Cuyahoga, Lake, Lorain, Geauga	TSP, SO_2
Columbus	Franklin	TSP
Dayton	Montgomery, Green, Clark	TSP, SO_2
Mansfield	Richland	TSP
Steubenville*	Jefferson, Belmont Columbiana, Monroe	TSP, SO_2
Toledo Interstate	Lucas, Wood	TSP, SO_2
Youngstown	Mahoning, Trumbull	TSP

*(40) CFR 41942) September 9, 1975

B. The Relationship of this Regulation to the Ohio Environmental Protection Agency Attainment Maintenance Program

It is not the intention of the USEPA to usurp the legislative responsibility of the State to plan for and implement geographic specific maintenance strategies. USEPA has made every effort not to interfere with the planning and development decisions of state, regional and local governments. For this rulemaking, the projection of emission growth rates (through surrogate variables) to 1985 provides three years to attain the NAAQS and 5 to 6 years of maintenance. This maintenance period is to provide an opportunity for the development of Ohio EPA maintenance SIP revisions. In utilizing this approach the USEPA in no way assumes to be promulgating maintenance plans in lieu of the State Air Pollution Control Agency (APCA) meeting the planning requirements as set forth in Part 51 Subpart D.(7) Compliance with that regulation unequivocably remains the responsibility of the State APCA, and the State regional and local agencies enlisted for assistance.

Although the dates will vary, the Administrator has proposed that Reasonable Available Control Technology (RACT) SIP revisions be submitted to the USEPA by July 1, 1977, and that all other revisions or SIP additions be submitted by July 1, 1978.(8) This additional year is provided to permit all State Air Pollution Control Agencies to seek the necessary authority for maintenance. This includes all regulations, ordinances, agreements, and delegations that are to be implemented within at least 10 years after attainment is achieved. Although the strategies proposed and adopted are to assure maintenance for at least that 10 year period, the States' analyses are to address a time period consistent with the target dates of other federally sponsored regional planning programs. Generally, the EPA-208 Areawide Wastewater Management Program, the Federal Highway Administration's Regional Transportation Planning Program, and the Department of Housing and Urban Development's 701 Comprehensive Land Use Planning have 20 to 25 year time frames. The Ohio EPA maintenance program is to include the spatial distribution of emissions and accordinly is to result in geographically specific control strategies. The States' selection of spatial resolution should be fine enough to distinguish special problem areas and special problem sources. For example, the maintenance program with local planning agency assistance should be able to distinguish the Central Business District from industrial parks and residential neighborhoods.(3)(7)

For many existing point and area sources, the spatial coordinates are available from the state or national emission inventory. For industrial and commercial/institutional new sources, there is often only limited information available on potential plan locations. Starting with the computation of emissions on a countywide basis, with account taken of new source regulations, the allocation procedure can take one of three paths with regard to locating new source emission:

1. Assume all growth in emissions occur at the same location as existing sources (i.e., growth in place).

2. Assume all growth in emissions occur at new sites and allocate according to an employment, land use, or other distribution function.

3. Determine the mix between growth of emission due to existing and new source activity, and allocate accordingly.(3)

For the purpose of developing the Ohio SO_2 emission control regulations to attain the national standards, EPA utilized the first emission distribution approach. It will be the States long-term maintenance program for all criteria pollutants which is to result in the inventorying of potential industrial activity and allocation of future emissions to a sub-county grid network.

C. Levels of Analysis

According to the maintenance regulation, the State is to perform its area analysis at the most detailed level. The EPA 14 volume guideline series on maintenance offers a priority system for States to plan their resource needs.(3) The prioritization is contingent upon the availability of valid and useful data. For the development of this Ohio SO_2 regulation to attain the national standards (and to provide a lead-in period of maintenance) EPA chose the Level 1 approach listed below.

Level 1: This level relies on data published by Federal or State agencies, and does not involve interviewing or a review of special country studies, like land use-transportion (or water) plans. It requires the least time, and hence cannot be expected to result in as accurate a projection (cannot result in sub-county projection) as the other levels. This level can be used for orientation and preparation for the other more complex levels.

The Ohio EPA now has the opportunity to utilize this work as the starting point for its more detailed subcounty maintenance analysis and planning. It is the states obligation to choose either of the two remaining levels of detail and to perform, or otherwise be responsible for, only urban area or statewide survey of point and/or area source emission growth potential. The levels of detail available for further more detailed analysis are the following two:

Level 2: The method specified at this level leads to projections of greater accuracy than those of Level 1, but would require more time to complete. It makes use of special data and studies done for the county, such as transportation, land use or water/sewer management plans.

Level 3: This level relies on extensive contact or interviewing with organizations responsible for the major pollution sources to determine present and future emissions. It is the level leading to to the most accurate projections, but as a result, the effort required is greater than that needed to complete projections at the other levels. (It is anticipated that contractual assistance of various local planning agencies, engineering or economic consultant firms will be available for each Level 3 maintenance effort.) Various methods for projecting change in industrial activity are outlined in the AQMA Guidelines, and there are a number of procedures which are suggested. In some cases the "default" projection reference method will use the AQCR, Water District, or SMSA growth factors from either the Bureau of Census or from the Bureau of Economic Analysis Economic Research Service (only where directly applicable with prior USEPA approval). For process emissions the estimated activity level for future years should ideally be forecast by the facility operating the process. If this is unsuccessful or impossible, alternative techniques are specified (the Guidelines) to determine future activity levels for individual processes by application of generalized industrial growth patterns.

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2. Federal Register (38 FR 6279) March 8, 1973
3. USEPA Guidelines on Air Quality Maintenance Areas
    - Volume 1: Designation of Air Quality Maintenance Areas
    - Volume 2: Plan Preparation
    - Volume 3: Control Strategies
    - Volume 4: Land Use and Transportation Consideration
    - Volume 5: Case Studies in Plan Development
    - Volume 6: Overview of Air Quality Maintenance Area Analysis
    - Volume 7: Projecting County Emissions
    - Volume 8: Computer Assisted Area Source Emissions Gridding Procedure
    - Volume 9: Evaluatin Indirect Sources
    - Volume 10: Reviewing New Stationary Sources

      APPENDIX - NEW SOURCE PERFORMANCE STANDARDS
    - Volume 11: Air Quality Monitoring and Data Analysis
    - Volume 12: Applying Atmospheric Simulation Models to Air Quality Maintenance Areas
    - Volume 13: Allocating Projected Emissions to Subcounty Areas

      APPENDICES A & B
    - Volume 14: Summary of AQMA Designations
4. Federal Register (39FR28907) August 12, 1974
5. Federal Register (40FR49048) October 20, 1975
6. Federal Reegister (41FR18382) May 3, 1976
7. Federal Register (40FR18382) May 3, 1976

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The reference document is available for inspection at:

1. USEPA, Region V
230 S. DEARBORN
CHICAGO, Ill., 60604

2. USEPA,
PUBLIC INFORMATION REFERENCE UNIT, LIBRARY Rm. 2922
401 M. Street SW
Washington DC. 20460

3. Ohio Environmental Protecting Agency
P.O. Box 1049
Columbus, Ohio 43216

SECTION VII

GROWTH PROJECTIONS

Section VII. GROWTH PROJECTIONS

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SECTION VII. GROWTH PROJECTIONS

INTRODUCTION

The purpose of the Growth Projections Section is to provide an emission control strategy which has the ability to maintain the NAAQS over a reasonable period of time for a reasonable set of possible urban and economic circumstances.

There are four major concerns in performing growth projections for the SO_2 standard maintenance:

(1) Selection of a methodology based on nationally reported data.

(2) Attempt to meet the needs of a predicted future. This would include the consideration of the impact of fuel shortages, fuel switch, and emission reduction from new source review and New Source Performance Standards. However, it would exclude any attempt to project and plan an optimum future as may be based on theoretical, academic or personal criteria.

(3) Recognition of the purpose of the projections in the control strategy development sections of this effort as clearly distinguished from cost-benefit and other types of analyses.

(4) Maintenance of consistency or substantiated resolution of conflicts with other available projections or forecasts of urban and industrial activity.

The selection of the growth projection methodology proved to be a function of the availability of valid nationally reported economic data over a representative period of time(1). The data categories provided by these reports are dependent upon the program requirements of the agencies for which they were prepared. This limits their usefulness for other analysis purposes. The overriding requirement in the selection of growth indicators was that it would be meaningful in terms of having a relationship to manufacturing activity and to generalized urban activity, and as such, to the generation of SO_2 emissions.

The USEPA recognizes its responsibility to carefully project any impacts that its actions may have on the costs, earnings, and production methods of manufacturers, and the impacts on the economy. We have made every effort to minimize biases in the data used in these projections, given the time and resource restrictions under which this analysis has been conducted.

The projections of industrial and general urban activity discussed here are simply tools to be used in these and other phases of the effort. The USEPA is aware of the range of forecasts of economic change for the 1975-1980, 1980-1985 periods(2). Should unexpected growths in emissions occur within the 10 year period, the USEPA and/or the OEPA may propose subsequent adjustments to the promulgated regulation and to the State Implementation Plan. Situations where this could occur include:

(1) Unanticipated growth in the level of manufacturing activity, thus accelerating the pace of the growth of projected emissions,

(2) Unanticipated changes in fuel mix, or in processes, thus accelerating the projected emissions.

A. Point Source-Industrial Projections

1. Categories of Counties

The Ohio Environmental Protection Agency maintains annual SO_2 emission inventories for 100 ton/year industrial facilities in each county(3). This listing makes it possible to identify, by Standard Industrial Classification (SIC), the geographic (county) concentrations of SO_2 emitting industries through the frequency of their occurrence. The frequency analysis performed (See Table I) reveals two important items: (1) there are 18 "Urban" counties with concentrations of diverse industrial activity, and (2) of the industries which appear in the greatest frequency, four are the most critical in terms of manufacturing activity leading to the generation of SO_2.

Urban county point source growth projections were calculated separately from those for the non-industrialized non-urban "Rural" counties. The term "Rural" is meant to indicate that the primary SO_2 emitting activity in the county is not from concentrated manufacturing activity, but rather from the sum of small point source and area source activity. Industries in Rural counties were treated as area sources except in the case of one major facility being identified and the data being inputted to the model for direct analysis. The rural counties otherwise received one generalized growth rate, derived from population change; while the urban counties received two growth rates, point sources SIC specific, and an area source specific population-change derived growth rate.

2. Growth Indicators

a. Evaluation & Selection

A frequency analysis of the 4 digit SIC codes of the Ohio EPA emission inventory results in the identification of 12 significant 2 digit industries, of which 4 are considered as being SO_2 intensive. A survey of nationally reported data reveals six indicators for the projection of SIC code activity. A cursory review reveals that not all of the indicators are reported on a county basis, not all are sufficiently uniform, not all are available over a representative period of time, and some are incomplete due to the Bureau of Census privacy and disclosure restrictions on 4 digit SIC information.

According to the AQMA Volume guideline "Projecting County Level Emissions," industrial activity may be projected as a function of total SIC category employment, manufacturing employment, total dollar earnings, value of shipments, and value added. Any indicator of industrial growth using employment requires consideration of the change in worker productivity due to the rate of technological change. The Bureau of Census reports employment, and the Department of Labor publications offer employment and dollar value output date categorized by industry SIC code for National trends and for State level activity.

Table 1. FREQUENCY of SIC CODES in COUNTIES

SIC	Description	Frequency
20	Food & Kindred Products	12
26	Paper & Allied Products	18
28	Chemical & Allied	6
29	Petroleum Products	7
32	Stone-Clay-Glass	18
33	Primory Metals	28
34	Fabricated Metals	5
35	Machinery (Except Electrical)	7
36	Electrical Equipment	5
37	Transportation Equipment	7

Source: 1974-75 OHIO EPA Emission Inventory.

NOTE: CBERS, and Census of Manufacturer's Reports more individual facilities in the state than are covered by the OEPD SO_2 emission inventory.

OBERS and Census of Manufacturer's Reports on more SIC code industries than are included in the OEPD SO_2 Emission Inventory.

Where National publications of county specific employment data are available, the subject matter is not sufficiently detailed to determine the relationship of employment levels to the generation of SO_2 emissions. Such limitations on employment data greatly limit its usefulness for this type of SIC-county specific projection. This indicator was not used.

The Bureau of Economic Analysis and the Economic Research Service (OBERS) constructs and publishes an indicator known as Total Industrial Dollar Earnings. This is a measure of the net earnings from all activities ranging from manufacturing, divestitures, and investments. Although this information is available for all 2 digit SIC codes and for many 4 digit codes, there are two reasons for its limited usefulness in these projections:

(1) The OBERS does not publish industry data on the county level (OBERS does provide specific data and forecasts for each SMSA, AQCR, Water Planning District, and State Economic Area).

(2) The indicator is not directly related to production activity.

The Annual Survey of Manufacturers does report both the value of shipments and the volume or weight units shipped on the county level. However, the data is not organized by SIC category, but rather by an assigned product-type number. In addition, value of shipments is not necessarily related to production activity, particularly at the county level. The

Department of Commerce Bureau of Domestic Commerce points out that this is especially true in times of high inventories.

The Federal Reserve Board (FRB) index "Industrial Production" appears in the FRB monthly reports. What is reported is not total production in production units, but rather the dollar value of the produced goods(8). This value appears both seasonally adjusted and non-adjusted as determined by the activity of the entire private market. The Industrial Production Index is a composite of manhours in the total private market and the specific SIC classification, productivity (as reported by the Department of Commerce), and industry reported output value. This last element is weighted with the value added factor for each industry category. The FRB indicator of growth is not used for two reasons:

(1) historic data before 1967 is particularly non-uniform, and

(2) the FRB uses 1967 dollars as their unity base point for measuring relative industrial change, whereas the SO_2 regulations use constant 1958 dollars and an emissions projection base year of 1972.

The final nationally reported industrial indicator evaluated was "Value Added". The Value Added factor is defined as an indicator of the final value of finished product less the initial value of the purchased materials used in production. The change in Value Added over time is taken as an indicator of the change in manufacturing activity. The indicator of historical growth rate is then applied to emissions, assuming one-to-one relationships between growth in activity levels and growth in emissions. By this method, use of historical changes in Value Added provides a means of projecting an emission growth rate. Attaining and maintaining the standards requires the projection of the impact on emissions of selected industrial activities, such as process techniques, fuel consumption, and fuel mix. For this purpose, the Value Added remains an accurate indicator of manufacturing activity.(4) (5)

The Bureau of Census, Census of Manufacturers publishes this information for all 2 digit and most 3 and 4 digit SIC codes for all counties (except as noted in A 2 b). These reports were initiated in 1958 and provide data for the years 1953, 1958, 1963, 1967 and 1972. The USEPA utilized the 1958 data as the starting point for determinating a historical trend. The 1953 values were rejected as a starting point because of their proximity to the skewed economic activity of post-World War II recovery. The 1958 and not the 1963 values were used as a starting point to permit a greater range of short-term business cycles to be included in the compounded annual average growth rate calculations.

As explained in A. 2. a, Growth Indicators-Evaluation and Selection, there exists a wide variety of nationally reported data, forecasts and projections of industrial activity. Because the various agencies produce these projections using different indicators of future activity, inter-projection comparisions are not useful. Section A. 2. a presented the rationale for the selection of SIC specific Value Added as the surrogate variable most reflective of the manufacturing process and goes on to present the reasons for the rejection of other indicators. Public comments received identified an interest in these other projections. Table 2 is a matrix of the national compound annual growth rates as calculated by the agencies (or EPA staff). An Ohio statewide comparison is given in Table 3.

While the choice of a starting point is a judgmental matter, it can affect the resulting growth rates. The choice in this case is limited by the data which exists for the years 1953, 1958, 1963, 1967, and 1972. A comparison of national growth rates in Value Added for the four industries during the period 1953 to 1963 shows higher rates of growth than those used for these projections, thus compensating to some extent for the use of a slump year as a starting point which would tend to exaggerate growth rates. It is also noted that while 1958 and 1972 are not directly comparable, 1972 represents a growth year (rather than a peak year).

Table 4 contains a list of urban counties for which Standard Industrial Classification Value Added data was derived and a list of SIC codes considered in these regulations.

Table 2. National Growth Rates

Compound Annual Average Growth

SIC	Value Added	Domestic Output $		Value of Shipment	Production Index	Total Earnings	Employment	
	1972-1985	1972-80	1980-85	1975-85	1958-72		1972-80	1980-85
20		2.8	2.0	8.4		4.3	0.2	-0.14
26		5.0	3.0	12.9		5.4	2.0	0.4
27		5.0	2.9	7.7		4.3	2.1	0.7
28	7.9	7.3	4.0	7.8	8.4	3.2	2.8	0.2
29	...	1.0	1.6	Not Available		5.1	-1.7	-0.6
30	9.4	7.7	4.4	5.3			3.9	0.7
32	3.9	3.6	2.8	Not Available		1.4	2.2	0.8
33	2.1	4.8	3.3	10.8	4.2	4.7	2.1	0.4
34	5.5	5.6	3.8	8.0	4.3	4.7	3.0	1.2
35	6.4	7.6	3.8	9.0	5.6	3.3	3.7	1.0
36	8.8	8.4	4.6	7.8	7.0	6.4	2.3	1.2
37	6.1	7.3	3.3	8.5	4.4	4.0	2.5	0.7
Source:	Census of Manufacturers, Vol. III Area	Structure of U.S. Economy in 1980 & 1985		U.S. Industrial Outlook 1976-1985	Federal Reserve Board	OBERS-E	Structure of U.S. Economy 1980-85	
By:	Calculations of Growth Rate USEPA Region V	U.S. Dept. of Labor		U.S. Dept. of Commerce	Calculated by USEPA Region V	OBERS	U.S. Dept. of Labor	
Date:	May 1975	1975		Jan 1976		1972	1975	

Table 3. Ohio Statewide Growth Rates

Compound Annual Average Growth

SIC	Value Added	Employment 1958-1972	Total Earnings 1970-1985	Electric Power Demand (Megawatts) 1970-85
20			2.1	4.5
26			3.2	4.3
27			3.4	4.2
28	8.24	1.75	4.0	4.3
29	2.40	0.00	2.8	3.5
30	7.56			4.9
32	2.98	-0.082	1.17	4.6
33	2.22	-0.26	3.3	5.4
34	5.92	1.64	2.1	3.5
35			21.7	4.7
36			22.0	4.6
37			1.6	5.3
Source:	Census of Manufacturer Vol. III	Department of Labor	OBERS-E	1975 State of Ohio Summary of Electric Statistics
By:	Calculations By USEPA Reg. V.	Calculated by USEPA Reg. V	Calculated By USEPA Reg. V.	Ohio Power Sitting Commission
Date:	May 1975	1976	1972	Feb 1976
				Investor Owned Power Generators

Table 4. Industries Considered (SIC) For Urban Counties

Ashtabula	28, 30 34
Belmont	32, 34
Columbiana	32, 34, 35
Cuyahoga	28, 32, 33, 34, 35
Franklin	20, 28, 32, 34, 35
Geauga	30
Hamilton	20, 26, 32, 34, 35, 36
Jefferson	33
Lake	32, 34, 35
Lorain	20, 34, 35
Lucas	20, 28,30,34,35
Mohoning	32, 33, 34, 35, 37
Montgomery	20, 26, 28, 33, 34, 35
Muskingum	32, 30
Summit	20, 32, 35
Stark	20, 26, 28, 30, 32, 33, 34, 35
Trumbull	32, 33, 34, 35
Washington	28, 34
Wood	20

D. Modifications and Exceptions

Three modifications to the projection procedures for county level industrial growth were required. These were due to:

(1) Bureau of Census disclosure protection requirements,

(2) Interstate SMSA's with changing centers of dominance,

(3) Anomalies of SIC 29 Petroleum and Refining DATA as presented by Census.

In each of the counties that these exceptions occurred, the modification was in the source and exact form of the growth indicator used. No change was made in the computational procedure for calculation of growth or in the application of the growth rate to the individual facilities. The appendix volume to this technical support document, containing the individual county value added growth rate tables, reflects these modifications.

The first type of modification in disclosure of data, was made because the Bureau of Census is prohibited from publishing data which could be recognized as being that of a specific industry or business located in a county. To prevent disclosure of this type of data, the Census publishes the value added, employment and earnings data on the Standard Metropoliton Statistical Area (SMSA) level, SMSA data is found on Table 6 of the Census of Manufactures Volume III document, while county data is on Table 7 of that publication.

This first modification applies to Stark county and in part, to Belmont county. Stark is the industrial half of the Canton SMSA, with Carrol county contributing significantly to the Stark county labor force. Although some distortion of the dominant county's industrial activity is inevitable, the Ohio EPA emission inventory has confirmed that the significant industrial processes are in stark county and thus the distortion is reduced.

Similiarily, had the Census published SIC specific data for Belmont County, the data could have been identified as being that of the few but significant, primary metal operations in the county. Belmont, as part of the Wheeling Interstate SMSA, received the national SIC 32 growth rate because of the absence of Census published data.

This second modification is applied to Jefferson County for SIC 33. Census of Manufacturing historic data is available for Jefferson County, but the data does not reflect the recent change of site location focus to the Counties of West Virginia. Thus the historic Jefferson County data and the SMSA data are not appropriate indicators of reasonably assumed future industrial activity for the Steubenville area. The SIC 33 growth rate applied to the Jefferson County facilities is again the national growth rates.

The third modification is an exception to the use of the 2 digit SIC identifier, and the use of national value added growth rates for the specific 3 or 4 digit SIC codes that are published. This modification only applies to the Petroleum Refining and Related Industries code number 29. Where SIC 29, or its 3 and 4 digit categories appear in the Ohio SO_2 Emission Inventory, the national growth rate specific to that industry code is used. 6 counties are reported by OEPA as having petroleum industries with SO_2 emissions of over 100 tons a year. Within the 6 counties are a total of 9 major facilities.

Frequency	County	SIC	Description	National Value Added Growth Rate
1	Mahoning	2994	Miscellaneous	.90%
2	Cuyahoga	2999	"	.90%
1	Green	295	Roofing	3.88%
3	Lucas	2911	Refining	2.35%
1	Hancock	2911	"	2.35%
1	Hamilton	2911	"	2.35%

Census of Manufacturers reports that there are 170 facilities in the broad 2 digit SIC code. The remaining 161 facilities (25 tons or less in SO_2) are considered area sources of emissions and their growth is included in the area source growth rate represented by the county population indicator (described in VIII C).

3. Facility Design Capacity and County SIC Growth Rates

As explained in Section VII, the application of the Level 1 analysis involves the projection of an indicator of total county industrial growth for each Standard Industrial Classification code. The growth rate produced represents growth-in-place for each facility existing in the period of 1958 to 1972. The growth rate of the indicator was then applied to the boilers and industrial processes of each individual facility. The boilers or process were then projected to grow to within their specific design capacity. The remaining projected growth is considered as new source growth and is allocated to the site if specific information relative to that source was available from the OEPA data gathering systems. The USEPA received public comments from USEPA Section 114 data request letters and other sources.

Where data was available (i.e., stack parameters, locations estimated normal annual operations, capacities, etc.) the projected regulated emissions from these new facilities were calculated subject to the provisions of NSPS and PSD. All information relative to the phase out of existing source operations were accounted for in the application of the SIC specific growth rates to the appropriate emission factors.

Below is the equation used to convert 1972 dollars into 1958 dollars by dividing 1972 dollars using the Office Of Business Research SIC State specific deflation figure.(8)

EXAMPLE

DOLLAR DEFLATOR
EQUATION

Y = 1972 total in 1972 value

Y^1 = 1972 total in 1958 value

$A\%$ = Adjustment Factor

$$\frac{Y}{A\%} = y^1$$

Example:

30,000 = 1972 value added total for SIC 32 county X

133.6% = Deflation Factor to 1958 dollars for SIC 32

1.336 = Adjusted Factor

22,455 is 1972 total in 1958 dollars

All Bureau of Census, Census of Manufacturers dollar figures are published in the value of the dollars for the years listed, no conversions have been performed by the Bureau of Census. Some Census dollar value columns include the word "adjusted", this does not mean that the dollars have been converted into the value of another year for comparison purposes, rather, the "adjusted" phase related to the construction of input data into that year's total dollar value. For interyear comparisons, dollars must be converted into constant value dollars. (See Table 5).

In future years, the USEPA, Ohio EPA, and Industry may wish to compare the projected value added dollar amounts contained in this support document with the Value Added dollar amounts for that future year. The future year dollar amount must first be converted into 1958 constant dollars (or to convert the 1958 value dollar into whatever future year value desired). The projected dollar values, in 1958 constant dollars, are presented in the appendix volume to this support document only for informational purposes, as only the rate of growth was used for this regulatory action.

TABLE 5. OFFICE OF BUSINESS AND
ECONOMIC RESEARCH SERVICE
(OBERS)
Industry Specific Dollar Deflation Figures
(Unpublished)

SIC	Factor to Convert to Constant 1958 Dollars		
	1963	1967	1972
20	108.8	117.1	123.6
22	100.9	108.5	102.4
26	98.2	106.4	115.9
28	96.3	95.9	91.2
29	115.5	154.6	157.3
30	93.2	94.5	101.2
32	101.5	106.0	133.6
33	105.1	114.6	144.6
34	102.7	114.3	135.5
35	105.3	114.0	127.1
36	92.3	86.3	90.6 *
37	104.7	115.1	131.4 **

* For the 1957 through 1961 period the value of product mix changes. Over the long run, these SIC categories will also be going up.

** SIC 37 plus SIC 19 (Ordinance) minus SIC 371 (Automotive). SIC 371 dollar deflator to 1958 base year is 114.9.

B. Area Source-Population Projections

1. Range of Alternative Indicators

Area sources are those industrial facilities emitting less than 25 ton/year SO_2 and the sum of urban activity which results in wide scale low quantity emissions. The emissions of the former group are from small or non-specified industrial processes; emissions from the latter group are predominately from space heating and incineration for institutional, commercial, governmental, and residential structures.

AQMA Guideline Volume Number 7 itemizes the available nationally published county level data(1). These include: employment, income, total dollar earnings for each commercial SIC code, tax revenues, total county employment, fuel distribution, housing unit changes, changes in total square footage or acreage, and changes in total county population. The first step in the evaluation and selection of an indicator of area source emission growth is to determine the relevance of the indicator to the generation of emissions. This step, as carried out in VII. A. Point Sources, involved the detailing of the conversions or modification to the indicator, or to components of the indicator, to make it useful for the projection of area source emissions.

Sales, taxes generated, and employment per SIC code on the county level are good indicators of the economic well-being of a specific category of urban activity of a specific geographic area. These indicators do not necessarily reflect the physical changes of facilities, nor the associated emissions. Square footage and acreage devoted to a category of urban activity do reflect facility growth but two characteristics of special data prevent its use in the projection of emissions. One, an increase in the space devoted to an activity (commercial, industrial parks, offices, hospitals or schools) does not define the specific activity to which the floorspace is being used. National reports do not explain (nor do local agencies survey) the percentage of facility expansion going to parking spaces, lunchrooms, meeting rooms, warehousing or to other non-production oriented uses. Two, the national reports only periodically include geographic specific vacancy rates. Local or regional planning commission data could be used as a source of this information, but only at a loss of analysis consistency and at the expense of considerable data collection time. Further, although national vacancy rate information is available for some categories of urban activity, there is no local requirement for facility owners to report whether or not the vacant facilities are being heated.

The indicator considered to be most directly reflective of urban area source emission growth is fuel use.(1) However, the nationally reported fuel data only presents the relative distribution of fuels throughout the nation. This is based on a survey of sales, tax records, and on state energy office permits. Fuels consumed are calculated by SIC category for SMSA's in the Annual Survey of Manufacturers, but does not exist for area sources and for individual counties.

Some Federal agencies or Regional Planning Commissions have attempted to monitor the fuel demand of their localities, but have not attempted to forecast demand or supply of total fuel, or fuel by user category, or fuel by type.

The indicator most consistent in reflecting short-term cycles, and most readily available is county level population. A wide range of county population estimates and projections exist for use as the surrogate indicator of the growth of urban area source emissions.

2. The Indicator Selected: Population

The growth rate derived from the population indicator is that of the growth of basic uncontrolled small scale manufacturing and space heating SO_2 emissions. It is to be kept in mind that the EPA does not intend to develop an alternative set of county population projections, and does not intend to duplicate or challenge the efforts of Regional Planning Commissions (RPC) funded by the Federal Highway Administration, Department of Housing and Urban Development. The sole purpose in using the Bureau of Census County Population P-26 Series was to develop an indicator of the growth of SO_2 emissions. The EPA projections cannot be used to determine an optimum county population growth rate. The county population growth rate tables in the Appendix to this support document do not contain projections of population. The regulation is based on the growth rate and does not use the existing or future county population totals.

Part A. describes the population projection methods commonly used by planning agencies and governmental units in Ohio. The intent is to make all parties aware of the population projections already available and to describe the range of methodologies employed in different geographic areas. Part B. describes the method by which EPA calculated the county population change for the projection of area sources of SO_2 emissions.

a. Comparison of Alternative Methodologies

Historical development holds a key place in the formation of forcasts or projections, whether they be of population, employment or other indicies. There are 5 principle methods for developing forecasts (projections) of population:

(1) trend projection

(2) apportionment or stepdown

(3) employment-labor force related

(4) housing unit residency rate related

(5) cohort survival

Certain assumptions and implications are contained in each of these methods. Depending on the nature of the forecasts being developed, and the present character of the area, one method may be more relevant than another in the formation of reasonable population projections. This range of methodologies, related to purpose, may result in differing growth rates.

Looking at the five alternatives within this context, the first method, a projection of historical trends in population to the forecast year, is probably the simplest and easiest method of developing projections for a study area. The complexity of factors responsible for the growth of population to its existing level is assumed to operate in the same manner in the projection years. The important element in using this method is the selection of the historical time period upon which the forecast will be based.

Second, the apportionment method involves deriving or accepting a study area projection for a larger geographic region of which the study area is a part. The historical relationship between population growth in the two areas is analyzed. The relationship can be assumed constant for a trend to be projected into the forecast period. The development of the study area forecast then involves combining the forecast of the broader region with the assumed relationship in the forecast years to arrive at the forecast for the specific study area. As with the trend projections, factors affecting the relative population growth in the two areas are assumed to continue in the forecast period. This method is readily adopted by planning agencies due to the ample supply of Federal geographic groupings and aggregations of data.

Historic data and projections are published by the OBERS for five categories of areas: the nation, the state level, water resource regions, SMSA level and on the Business Economic Analysis (BEA) level and for AQCRS. Further, most of these reports are available with the Series C, D, and series E birth rates. The Bureau of Census publishes projections for subareas, such as, urban areas under 5,000 people, townships, counties, SMSA's, State Economic Areas (SEA), States, and the Nation. The Army Corp of Engineers uses drainage basins and the USEPA occasionally uses the Air Quality Control Region Aggregation developed in 1971 for reporting purposes.

The third method is employment-labor force related. There are a number of factors which can have a potential impact on the population growth of an area. Several examples are geographic location, climate, and general economic growth. For this method, assumptions must be made about the levels of unemployment and participation of the population in the labor force. This method is particularly popular to Regional Planning Commissions because the employment data is readily available and relatively accurate from the State employment security offices. The overriding detriments to projections based on employment are: (1) an assumption of the number of people each worker is to represent, (2) double counting of workers holding second jobs, thus inflating the population estimates, and (3) the lack of confidence in estimating the percentage on non-county residents working (and thus counted) in the county.

The fourth, or housing unit residency rate, method is very similar to the employment indicator in that a relationship is assumed to exist between the absolute number and type of housing units in the county and the number of residents associated with each unit. Local and regional agencies, again, tend to favor this method because most communities keep records of the permits for construction of housing and on school enrollment (for the determination of number of children per 2 parent residences). Detracting from the accuracy of this indicator is its very premise. Communities are under no obligation to issue and record housing permit data in any consistent or uniform way. It is only occasionally that the permit data will identify the type of housing being built, the type of ownership pattern expected, or the number of bedrooms being provided. The decadinal census does publish this type of data, but only as the result of surveys.

Another facet of the projection of population estimates based on housing is that the local planner must assume some trend will continue for the future years. The discrepancy most likely to occur is an over-weighting of housing starts and occupancy of one county (suburb) of an urbanized area over another county (suburb) of the urbanized area.

The final method, or cohort-survival method, enables one to subdivide population change into its three component parts: births, deaths, and net migration; and to develop population forcasts based on assumptions for these three key components. The method is called cohort-survival because the Bureau of Census reports population data by sex and five year age groups or "cohorts". By making assumptions about mortality rates by age and sex, the current population can be survived into the future by five year intervals. Births and the 0-4 population can be introduced into the forecast by introducing assumptions about the fertility of females in their child bearing years.

This method is inappropriate for use in projecting general urban activity because it is assumed that the people born in the 1970 to 1975 year period will not be starting households or utilizing commercial facilities in the 1975 to 1980 period.

All Regional Planning Commissions for major Ohio metropolitan areas were contacted to provide EPA with currently used growth projections. In addition to each being constructed with different assumptions and techniques, the EPA review revealed many apparent discrepancies and possible discrepancies with other published data. In some cases, the discrepancies are real and the Regional Planning Commissions have been asked to re-evaluate the accuracy of their county level population estimates. Many of the apparent differences may be explained through an examination of the projection methodologies and local assumptions (See Table 6). Since only the rate of change is used in determining the county SO_2 growth rates, no attempt was made to equalize the EPA projections to the locally generated population projections.

One major source of population projections that Regional Planning Commissions utilize is the Ohio Department of Economic and Community Development (ODECD). The ODECD publications are the State endorsed county level population projections, although, substitutions are permitted on an ad hoc basis. The projections were evaluated by EPA and were rejected because of inherent discrepancies in their application. In the late 1960's the Battelle Memorial Institute-Columbus Laboratories developed the

TABLE 6. OVERVIEW OF POPULATION PROJECTION ACTIVITIES OF RESPONDING PLANNING AGENCIES IN OHIO

Coutny Projections	AMATS (Akron)	NOACA (Cleveland)	Mid-OhioRPC (Columbus)	EDATA (Youngstown)	Richland County RPC (Mansfield)	TMACOG (Toledo)	SCATS (Stork Co.)	OKI (Cincinnati)
Population Trend		X						
Employment	X	X					X	
Housing								X
Cohort-Survival	X	X					X	
ODCED			X	X	X			
Other						X	X	X
Base Year	1970	1970	1960	1970	1970	1970	1970	1970
Target Year	2020	1985	2000	2050	2000	2000	2020	2000

AMATS - Akron Metropolitan Area Transportation Study
NOACA - Northeast Ohio Area Coordinating Agency
Mid-Ohio RPC - Mid Ohio Regional Planning Commission
EDATA - Eastgate Development and Transportation Agency
TMACOG - Toledo Metropolitan Area Council of Governments
SCATS - Stark County Area Transportation Study
OKI - Ohio-Kentucky-Indiana Regional Planning Commission
OCECD - Ohio Department of Economic and Commuhity Development

DEMOS econometric model to project labor market areas for the Army Corp of Engineers. These labor market areas were similar to the State Economic Area (SEA) grouping of counties of the Bureau of Census. Employment, work, and population projections were produced by Battelle in 1970. The SEA projections were then disaggregated by the ODECD without the participation of the Battelle staff assigned to the DEMOS project. Battelle issued a disclaimer to the ODECD district and county interpretation of the data. The Battelle Statement, included in the appendix warned that care should be taken when using the ODECD results for individual counties.

An analysis of the OCECD interpretation of the Battelle data reveals a disproportionate weighting to the core industrialized counties. When compared to historic Bureau of Census data the following OCECD distortions appeared:

a) Urban core counties were higher approximately one third of the time

b) Rural counties were lower approximately two thirds of the time.

c) ODECD was 5 to 10% higher than the 1974 Census 18 times

d) ODECD was 10 to 15% higher than the 1974 Census 7 times

e) ODECD was 10 to 15% lower than the 1974 Census 17 times

f) ODECD was 10 to 15% lower than the 1974 Census 5 times

g) Near equal 41 times

The above analysis is supportive of the EPA selection of Bureau of Census data because of the methodology used in relating population to growth in SO_2 emissions. The urban industrialized counties received a set of point source growth projections and a separate population projection for area sources only, while the rural counties had the area population growth rate serving as the indicator for all activity, point and area source. The occurrence of higher Census numbers for the rural counties is acceptable because of the dual emissions components which population is to represent. The lower urban county Census numbers are acceptable because of the smaller role housing plays in the older core industrial counties.

D. Methodology Selected

The calculation of the county level growth rate was made by applying the compound average annual growth rate of the 1970 to 1974 period to each subsequent year to 1985. The input data was the county populations total constructed by the Bureau of Census and published in the P-26 Series. The use of the P-26 Series complies with the requirements set forth in the Office of Management and Budget Circular A-46 implemented June, 1975.

The EPA selection of the April 1970, 1971, 1972, 1973, and provisional 1974 population estimates was based on the reasonable assumptions that the historically high fertility rates and extended fertility women's age range of the 1950's and 1960's which decreased in the first half of the 1970's would not go into a major upsurge without eventual compensation in the 1975-85 period.

The following equation was used to calculate the compound average annual growth rate.

A) $P_t = (1 + GR)^T P_o$

B) $\left(\frac{P_t}{P_o}\right)^{1/T} = 1 + GR$

C) $\left(\frac{P_t}{P_o}\right)^{1/T} - 1 = GR$

D) $GR \times 100 = \text{Growth Rate}$

P_t = end data year

P_o = initial data year

T = number of years in timespan of data

3. Area Source Exceptions - The CDM Cities

The Climatological Dispersion Model (CDM), described in Section IX, requires the separation of area sources of emissions into two categories: Industrial/Institutional and Commercial/Residential. An EPA contractor performed this separation of base year emissions for the CDM cities of Akron, Toledo and Cleveland. (See Section IV). Providing these and the other CDM cities with emission growth rates required a modification to the approach of using total county population as the area source growth rate indicator.

For the industrialized core counties, the growth of ancillitory industry is assumed to keep pace with the primary manufacturing operation which they serve. This permits us to assign the average of all SIC growth rates for the county to the Industrial component of the Industrial/Institutional area source category. Institutional growth will appear as an increase in emissions from the addition of boilers and space heating capacities, the emissions of this growth component are considered minimal.

Commercial and residential development in the older industrialized core counties is not expected to grow at an appreciable rate; in fact, declines of this category are not unusual. These components of the area sources of SO_2 emissions are sensitive to shifts in population and in population centers. Consequently, total county population change serves as an appropriate indicator of growth.

References VII

(1) USEPA Guidelines for Air Quality Maintenance Planning and Analyses Volumes 1-14.

(2) Range of Alternative Federal and State Projection Sources:

Office of Business Economic Research Service (OBERS)
US Department of Labor
US Department of Commerce
US Department of Commerce Bureau of Census
Federal Reserve Board Buletins
Ohio Department of Community and Economic Development
Ohio Power Siting Commission

(3) Ohio SO_2 1974 and 1975 Point Source Emission Data System (PSEDS).

(4) Users Guide to the 1970 Census: Parts 1 & 2.

(5) Ohio Power Siting Commission: Forecasts to 1985.

(6) Census of Manufactures, area, Volume III, Table 7, US Department of Commerce, Bureau of Census.

(7) Census of Manufactures, Area, Volume IV, Table 6.

(8) "Implicit Deflation Figures, Nationwide, Industry SIC Specific" Regional Economic Analysis, Office of Business and Economic Research, Department of Commerce, May 1975.

(9) Region V USEPA Procedures to Assure Consistency in the Use of Population and Industrial Projections.

(10) Telephone conversation with Milton Elsen, Acting Chief of Industrial Division, Social & Economic Statistics Administration, Bureau of Census, Dept. of Commerce, May 1975.

(11) Telephone conversation with Edward Trott, Regional Economic Analysis, Office of Business and Economic Research, Dept. of Commerce May 1975.

(12) "The Projection of Economic Activity for Air Quality Control Regions" Bureau of Economics Analysis, U.S. Department of Commerce for USEPA, August 1973.

(13) "City and County Data Book", 1970, Bureau of Census.

(14) "The Contribution of Urban Planning to Oil Quality" USEPA 450/3-75-038, Feb. 1974.

(15) Telephone Conversation with James Diehl and Lenard Westerion, Bureau of Mines, Department of Interior, May 1975. (See Appendix to Analitical Procedures and to Modeling Results).

(16) "1972 Census of Manufactures: Fuel and Electricity Consumed" Bureau of Census, Department of Commerce, MC72(SR)6. (See Appendix to Analitical Procedures and to Modeling Results).

SECTION VIII

DESCRIPTION OF METHODOLOGIES

SECTION VIII. DESCRIPTION OF METHODOLOGIES

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SECTION VIII DESCRIPTION OF METHODOLOGIES

Introduction

This portion of the technical support document describes, in detail, the various "methodologies" that were developed for application in this rulemaking. In essence, the term "methodology," as used in this document, refers to the various techniques for applying air pollutant dispersion simulation models in conjunction with the appropriate input data (i.e., air quality, emission inventory, and meteorological data) to arrive at predictions of annual or short term air quality concentrations. The various methodologies applied in the development of the SO_2 control strategy were aimed at the optimal use of available input data, in order to maximize the accuracy of predicted air quality concentrations.

The following minimum data concerning a point source are required input to a dispersion model: pollutant emitted; average emission rates (short term emission rates may be desirable); physical stack parameters such as height, diameter, exit velocity, and exit temperature; and location of the source in appropriate grid coordinates.

Required area source information would be (1) total fuel types and consumption on a county basis, (2) the physical size of the area (grid square) over which emissions are apportioned, (3) a representative average stack height for the area sources, and (4) the location of each area source or grid square in the modeling analysis area.

The techniques used in practical application of the air pollutant dispersion models to arrive at valid predictions of ambient air quality concentrations are referred to as "methodologies". Different methodologies were applied in various areas of the State of Ohio. The methodologies for each area were selected based on a determination of an appropriate dispersion model for the area and the availability of adequate input data for the model.

The overall methodologies utilized in the development of this final rulemaking were as follows:

1. The urban analysis employing the CDM, the CSDFP and RAM models.
2. The urban analysis employing the RAM model exclusively.
3. The urban analysis employing the proportional modeling technique in conjunction with the MAXT-24 single source short-term model.
4. The isolated, rural single source analysis with the MAXT-24 model.
5. The contiguous, rural multiple-source analysis with the SCIM (or RAMR) program.

Each of the above-referenced computer dispersion models (plus the proportional modeling techniques) are described in detail in Part IX. The following discussion centers upon the five methodologies identified above. The methodologies used for urban analysis is discussed first followed by the rural analytical methodologies.

VIII.A. URBAN ANALYSIS

The analytical methodologies used in the development of urban control strategies consisted of the combined use of (1) the Climatological Dispersion Model (CDM) and the Control Strategy Development Forecast Program (CSDFP) and the Realtime Air Quality Simulation Model (RAM) in three selected urban areas; (2) the sole use of RAM in three urban areas with short term air quality problems; and (3) the Modified Rollback Analysis in three urban areas with special terrain problems. The major reasons for modifications in the overall urban methodology employed in developing the final regulations were to: 1) adequately analyze and develop regulations that would assure compliance with the short term standards (i.e., the addition of RAM); 2) develop control strategies directly related to the impact of specific sources on air quality rather than testing the overall impact of a fixed set of predetermined strategies; and 3) use of a modified proportional modeling approach that categorizes emission sources and the amount of required emission reduction within specified source categories.

Before describing the details of each urban methodology, a description of the procedures and theoretical basis for the statistical calibration of the CDM model as applied in three urban areas will be given.

VIII.A.1. MULTIPLE REGRESSION ANALYSIS

The fluctuations in a given series are seldom dependent upon a single factor or cause. The measurement of the association between such a series of variables associated with the dependent variable which may be affecting the fluctuations is known as multiple correlation.

Multiple correlation is, therefore, the measurement of the relationship between a dependent variable and two or more independent variables. Since two independent variables are available from the CDM output, (i.e., point source concentration estimate, and area source concentration estimates) a multiple correlation analysis is possible. The procedures are similar to that for a simple linear singular regression, with the exception that other variables are added to the regression equation. For the case of the CDM, it was assumed that a linear relationship existed between the two CDM independent variables and dependent variable (i.e., the air quality concentrations at each monitoring site. The linear relationship can be expressed by the following equation.

$$Y = m_1 X_1 + m_2 X_2 + b \qquad (1)$$

where Y is the dependent or estimated variable and X_1 and X_2 are the independent variables (point source and area source theoretically estimated contributions to air quality).

The coefficient of net regression given in equation 1 as m_1 and m_2 measure the average or expected change in Y for a given unit change in X_1 or X_2. These coefficients are also known as the slopes of the regression line. The intercept of the regression line is given by b in equation 1. The measure of association between predicted and measured data points can be expressed by a multiple coefficient of correlation. The mathematical expressions used in calculating each coefficient can be found in Appendix B.

VIII.A.2. MULTIPLE CONTIGUOUS SOURCE DISPERSION MODELING

The analysis of air quality impact and development of viable control strategies to meet the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide in six urban metropolitan areas (which encompassed nine counties) was done with the aid of atmospheric dispersion modeling techniques. The Cleveland, Toledo and Akron metropolitan areas were analyzed using a combination of the CDM, CSDFP and RAM models, while Columbus, Canton and Dayton were analyzed using RAM alone.

The steps involved in the Overall Urban modeling methodology are given in Figure 1. The procedures involved in the analysis of compliance with the annual standard are essentially the same as those utilized in the methodology described for the proposed regulations[4]. As described in Section II and Section IV of this document, changes to the emission inventory and air quality data base were made in response to public comments. New data was obtained thru the public comment process and thru re-examination, compilation and verification of existing data. The same meteorological data used for CDM in the development of the initially proposed regulations was used in the development of the final rulemaking.

After the CDM was calibrated with a common base year of data, the CSDFP was employed to project point and area source emissions to the 1985 projection year. All point source emission growth was assigned by standard industrial classification (SIC) and were applicable to "in-place" expansion of industrial facilities. Growth due to new facilities was included where confirmation of projected pre-construction contracts were known and data to adequately model the facility were availabe. A further explanation on the use of growth data is given in Section VI. Wherever New Source Performance

Standards were applicable, they were used in projecting emissions. The 1985 unregulated emission projections, plus a grided set of source-specific receptors and a five year average set of meteorological data are input to the calibrated CDM to project unregulated 1985 air quality concentrations. Compliance with the annual standard throughout the receptor network was checked and source-specific adjustments were made by examination of source/receptor contribution tables.

A concurrent path (see Path 2; Figure 1) was used for analysis of compliance of the short-term standards. Hourly meteorological data and emission inventory data based on design operation of each source were input into the RAMF program to produce annual cumulative frequency distributions for 24-hour averages at a predetermined set of receptors. The selection of receptors was based on the distribution of sources across the study region and the specific locations of significant (i.e., likely to have large air quality impact) point sources. The second highest predicted concentration and the day of occurance at each permanent receptor were then tabulated from the printed output of CUMF (Figure 1). These dates were ranked in accordance with their associated ground level concentrations. Beginning with the day associated with the highest of the second highs, the source-receptor contribution tables were examined to determine which sources were the principle contributors to that receptor. Using these source-receptor relationships, a set of at least five days were selected for a critical day analysis. This set of critical days reflects those meteorological conditions (for the year of record) under which specific sources or groups of sources would have significant air quality impact.

Each of these critical days of meteorology along with the identical source emission inventory data that was input to RAMF were then input to the selected day version of RAM for analysis of critical source receptor pairs. Area wide coverage of source groups were handled with the RAM honeycomb receptor selection option. Compliance with the 24-hour and 3-hour standards were examined at each receptor and, if violations existed, source-specific emission reductions based on the source contribution tables were determined. These source-specific emission reductions were compared with those required by CDM to determine test strategies. Both CDM and RAM were then re-run with the test strategy emission inventories to assure that all standards would be achieved. Adjustments to final strategies were made where required.

Technical description of CDM, CSDFP and the RAM programs can be found in Section IX of this document.

VIII.A.3. MODIFIED ROLLBACK MODELING

The complexity of terrain around three of the urban areas in Ohio prohibited the valid application of presently available dispersion modeling techniques for evaluation of control strategies for low level sources. Those facilities with taller stacks, however, permitted analysis with the MAXT24 single point source terrain adjustment model. Descriptions of all models can be found in Section IX of this document.

Because contributions to the total atmospheric content of sulfur dioxide from mobile sources is small, emissions from this source category were not considered in this analysis and $T_{i,j}$ in the modified rollback equation (1), in Section IX.C is equal to 1.00.

A stationary source height factor of 1.00 was used for all sulfur dioxide emission sources (i.e., K_i in the modified rollback equation is equal to 1.00). Because all sources of emissions in this analysis were elevated above ground level, this standardizes the procedure and treats all sources equivalently with respect to dilution.

All available air quality data in the respective study areas were reviewed and considered for this analysis. The highest base year 24-hour second maximum, and annual arithmetic average ambient sulfur dioxide concentrations were used in the analysis. In addition, 24-hour and annual average background concentrations were also utilized. All values were representative of the region of study. Detailed discussion of air quality data for each urban area is presented in Section II of this document.

Emissions inventory data were obtained by individual sources and were further categorized by Standard Industrial Classification (SIC) codes. Growth rates representative of the region were obtained by SIC codes as referenced in Section

VII.

The concentrations of sulfur dioxide can vary markedly within a region since the distribution of sources throughout the region may vary. For this region, the modified rollback model has an added capability of accounting for the spatial distribution of sources by giving greater weight to the growth, controls, and emissions of local sources than to regional sources. This methodology was not specifically utilized however, after a close examination was made of each area studied with the model. Because of the availability of air quality data, most areas were further divided into subareas. Then when considering the sources which would impact the respective monitors, it was concluded that the primary impacts realized at the monitors would be due to sources within a limited radial distance from the monitor.

Using the modified rollback technique, emissions were obtained for 1985 assuming no regulations were effective (i.e., the status quo was assumed for operating conditions for the sources indluded in the inventory, and the emission factor ratio therefore equals 1). The increase in emissions between the base year and 1985 determines the increase in existing SO_2 concentrations due to increases in anthropogenic sources (the difference between maximum ambient and background SO_2 concentrations). After applying the growth in emissions to the existing anthropogenic concentrations, future background concentrations are added and future ambient levels of sulfur dioxide are projected in order to determine if, or to what degree, violations of the National Ambient Air Quality Standards would occur under the present operating conditions of emissions sources.

In those areas with existing and projected violations of the NAAQS, the proportional technique was used to determine what degree of control of SO_2 sources would be necessary to insure compliance with both the annual and 24-hour NAAQS. Emission limitations were then applied to each source category and total concentrations were then recalculated with the modified rollback model to insure that the resulting decreases in emissions were adequate in providing for the attainment and maintenance of the standards. In applying the model, the overall percent reduction required is that value, either for the annual or 24-hour time period, which required the greatest reduction in emissions.

When existing and projected concentrations are still below the standards, calculations are performed to determine what regulations are required to prevent violations of the National Ambient Air Quality Standards or the conditions stipulated in the Prevention of Significant Deterioration Regulations (PSD). Annual as well as 24-hour values were used to determine which limiting case is used in the urban area within the framework of both the NAAQS and the PSD Regulations.

Appropriate emission factor ratios were calculated for each of the cases discussed above. When violations of the standards were realized in the future, emission factor ratios were less than 1, indicating the effects of the regulations would be more restrictive or limiting than the status quo operating conditions. When projected concentrations were still below the standards, emission factor ratios were equal to or greater than 1. The emission factor ratios were calculated by determining the ratio of the proposed emission limit for an individual source by the existing or status quo emission level for that source.

The proportional technique was used only as general guidance in determining what overall reductions are required from emissions sources in the region of study. Once the total reduction required was calculated, regulations for separate sources such as coal fired boilers, oil fired boilers, process operations, coke oven battery operations, etc., were developed. The effectiveness of these source category specific regulations was then tested with the modified rollback model and their adequacy in providing for attainment of the standards was tested. The model was rerun for different combinations of strategies until a set was found which achieved the desired emissions reduction.

VIII.D. RURAL ANALYSIS

1. ISOLATED POWER PLANTS SINGLE SOURCE MODELING

This analysis used the design emission rates and stack parameters in order to assess the impact of each power plant and to relate that impact to the standards for strategy development. A flow chart of the methodology described below is in Figure 2.

The emissions inventory was compiled for each power plant listing the design sulfur dioxide emissions, design stack parameters and source locations.

The PTMAX program was utilized for each power plant to determine the five critical downwind radial distances. The elevation of each of the 180 receptors associated with the 5 distances was determined from USGS maps (7.5' series).

The receptor elevation data set, the meteorological data set most representative of atmospheric transport and dispersion in the area, and the source emissions inventory are input to a series of MAXT24 runs, one for each stack and for the entire facility. From the table of second maximums for both the 3-hr. and 24-hr. averages the day of occurrence and location for each stack is determined. Additional runs of MAXT24 are made using meteorology of a single selected day to develop a source-receptor contribution table for each critical receptor. Adjustments to the contributions were made where warranted by source geometry. The MAXT24 run of the entire facility verified that the critical receptor for the entire facility was one of the receptors determined by the individual stack analysis.

The source-receptor contribution tables, one for each stack, for both the 3-hr. and 24-hr. averages were used to develop the compliance option equations. These equations are based on the fact that the ground level concentration is proportional to the input emission rate for the same set of meteorological conditions. Each equation is an inequality in which the sum of the contributions from each stack must be less than, or equal to, the standard minus background. The operators of the power plant can adjust the contribution of each stack by the ratio of an emission limit of their choice to the status quo emission limit. However, any such combination of adjustments must always meet the equations and thus the standards. To insure that a choice of emission limits does not simply change the maximum impact point of the facility, an equation for each critical receptor was developed. The final equations were normalized to one and redundant equations were eliminated.

To illustrate this procedure, the compliance option equation for the Muskigum River Power Plant is calculated below from the following general equation:

$$NAAQS - BG \geq \frac{\chi_1}{E_1} EL_1 + \frac{\chi_2}{E_2} EL_2 + \quad \frac{\chi_n}{E_n} EL_n \qquad (1)$$

where:

χ_i = Stack i contribution in $\mu g/m^3$

E_i = existing emissions from stack i in pounds/MMBTU

BG = Background concentration in $\mu g/m^3$

EL_i = Stack specific emission limit option in pounds/MMBTU

n = no. of stacks

Substituting the data given in Appendix A for the above plant; and normalizing the left hand side of equation (1) results in the following compliance option inequalities:

$$1 \geq 0.0403 EL_1 + 0.0325 EL_2 \qquad (2)$$

$$1 \geq 0.0310 EL_1 + 0.0443 EL_2 \qquad (3)$$

$$1 \geq 0.0773 EL_1 + 0.0622 EL_2 \qquad (4)$$

$$1 \geq 0.0902 EL_1 + 0.0641 EL_2 \qquad (5)$$

Since these equations are inequalities, a finite subset of the set of solutions to equation will satisfy the other equations. Therefore, only critical equation 4 appears in the regulation. The uniform emission limit is the solution of this equation where $EL_1=EL_2$. In most cases the number of equations cannot be reduced to a single equation and all the equations must be satisfied simultaneously if this option is selected. For those facilities where a new stack is subject to NSPS, the contribution of that stack is moved to the left-hand side of the equation prior to normalization of the equation.

VIII. B. 2. Isolated Industrial Facility and Contiguous Source Analysis

This analysis used the design emission rates and stack parameters in order to assess the impact of each rural source and to relate that impact to the standards for strategy development. A flow chart of the methodology described below is in Figure 3.

An emission inventory was assembled for each county listing the design sulfur dioxide emissions, design stack parameters and source locations. Whenever a source is capable of utilizing different fuel types, the worst fuel with respect to sulfur dioxide emissions was used.

Each source within a county was examined with respect to its distance from the other sources in the county. Those sources found to be sufficiently isolated from the others followed the top path of Figure 3. Sources with possible interaction followed the lower path. Any case of doubtful interaction also followed the interaction path.

The isolated source was analyzed with the MAXT24 program using design load emissions and stack parameters along with meteorological data from locations representative of atmospheric transport and dispersion in the area. The five downwind distances were determined in the same manner as the power plants from PTMAX runs.

The second maximum 24-hr. concentration and the second maximum 3-hr. concentration were identified from the model runs for strategy development. The ratio of standard minus background to the corresponding second maximum concentration and the ratio of the second maximum concentration plus the corresponding PSD increment to the second maximum concentration were calculated. The minimum of these four ratios was the basis for the strategy. A ratio less than one indicated that reductions are required.

The strategy emission limit was this minimum ratio multiplied by the status quo emission limit in lbs. SO_2/MMBTU actual heat input for fuel combustion sources and lbs. SO_2/ton actual process weight for process sources.

For sources considered to be part of a contiguous group where the interaction between sources is important, each source was first analyzed with the MAXT24 procedure described in the previous paragraph. However, the results were used to select critical days for individual stacks for further analysis. From the tables of second maximums, the days on which the highest second maximums occurred were chosen as the critical days. The number of days selected ranged from 10 to 30 depending on the magnitude of the concentrations, the number of source stacks, and the differences of meteorological conditions for the days. These critical days were run with the spatially separated source inventory in either RAMR or SCIM. The source-receptor contribution table was used for evaluation of the maximum interaction between sources. Each critical receptor was compared with the standard minus background or the PSD increment in a manner similar to that described above to calculate a minimum ratio which is multiplied by the status quo to obtain the strategy emission limit.

The strategy emission limits determined from the isolated or contiguous grouping analyses or both were used for the final regulation. This final step varied from county to county depending on the results and is described individually for each county in Section IV. The technical descriptions of RAMR, MAXT24, and SCIM can be found in Section IX of this document.

VIII. C. Assumptions in Data Base Preparation for Modeling Analysis

A description of the collection, verification and compilation of the emission inventory, meteorological and air quality data base utilized in the analysis is described in Section II of the document. Although the data base collated was quite extensive, a number of assumptions with regard to its use in the dispersion modeling analysis had to be made to assure the results would be meaningful and valid. These assumptions can be summarized as follows:

1) For the analysis of compliance of the short-term standards not to be exceeded more than once per year, emission rates were assumed to be at the maximum rated capacity of the specific facility, if the data required to calculate these emissions were available.

2) In cases where a source was capable of using a mixture of fuels, the fuel of the worst quality (highest sulfur content) was used to evaluate short-term air quality impact. If the modeling indicated source reduction would be required, the amount of reduction needed was rolled back from emissions based on worst quality fuel.

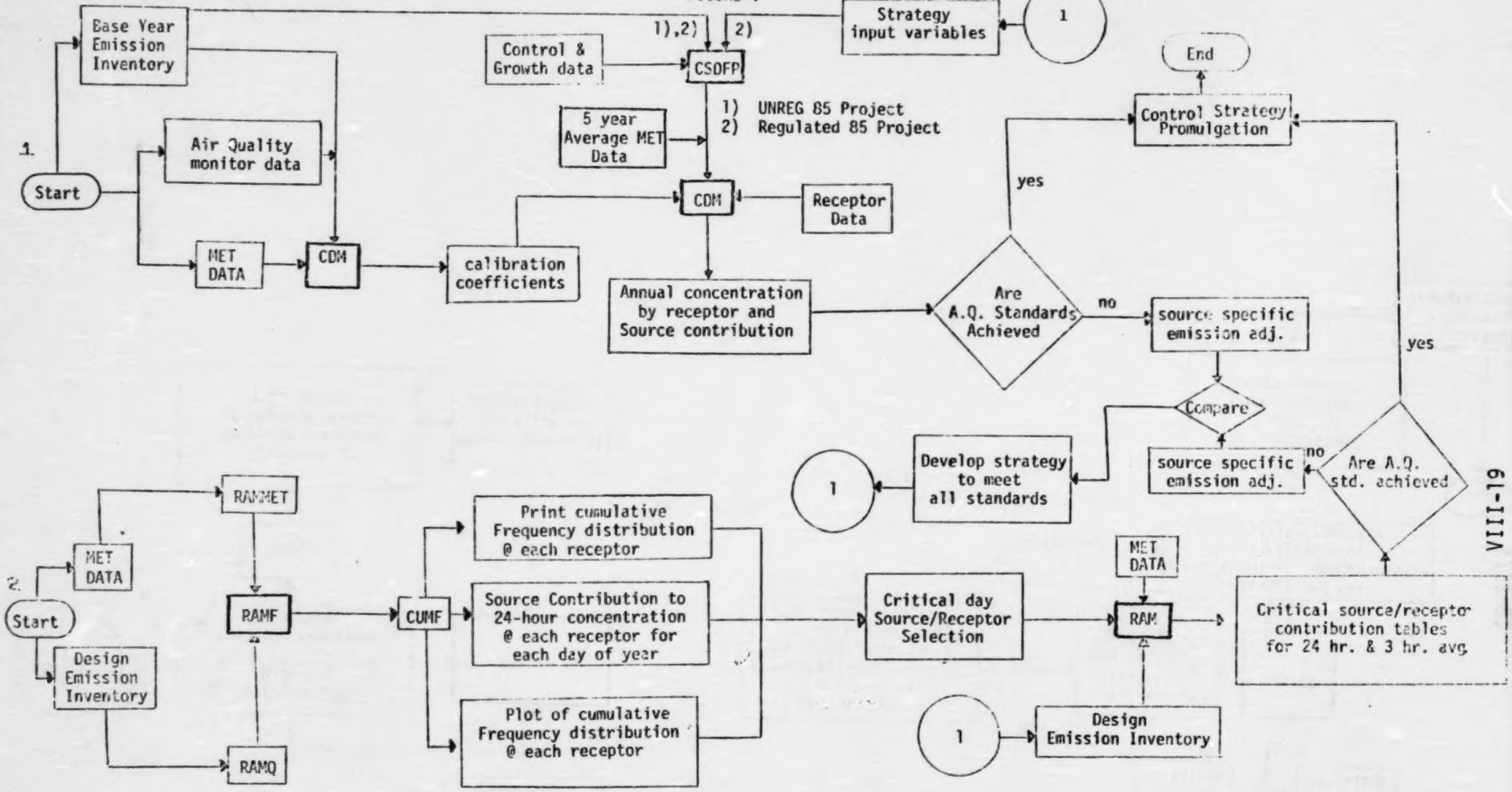
3) For this study actual measured hourly surface and twice-a-day upper air observations for 1964 were used in the short-term modeling. The reasons for this choice of data are: 1) surface data from earlier years do not have sufficient resolution in wind direction; and 2) surface data from subsequent years are readily available on magnetic tape

only for every third hour. Mixing height data for 1964 are obtained from the twice-a-day upper air observations made at the nearest upper air station. Hourly mixing heights are estimated by the model with an objective interpolation scheme. The respective surface and upper air meteorological stations most representative of transport and dispersion in the vicinity of each plant are identified in Section V.

4) Plume rise calculations for non-buoyancy dominated plumes (low effluent exit temperatures) were made for a select number of sources by comparing the Briggs' rise calculation with rise predicted by Stumke[2,3] or by Rupp's jet formula for cold plumes. The highest rise was then used to estimate the effective plume height in the CDM modeling.

5) Diurnal variations of emissions from residential, institutional and commercial area sources were accounted for by examining heating degree days, mean seasonal temperature and day-night temperatures differentials. Details of the methodology can be found in Appendix B.

URBAN STRATEGY
ANALYSIS
FIGURE 1


1.
Start
Base Year Emission Inventory
Air Quality monitor data
MET DATA
CDM
calibration coefficients
Control & Growth data
1),2)
2)
CSOFP
Strategy input variables
1
5 year Average MET Data
1) UNREG 85 Project
2) Regulated 85 Project
CDM
Receptor Data
Annual concentration by receptor and Source contribution
Are A.Q. Standards Achieved
yes
no
End
Control Strategy Promulgation
source specific emission adj.
Compare
source specific emission adj.
no
Are A.Q. std. achieved
yes
Develop strategy to meet all standards
1
2.
Start
MET DATA
RAMMET
Design Emission Inventory
RAMQ
RAMF
CUMF
Print cumulative Frequency distribution @ each receptor
Source Contribution to 24-hour concentration @ each receptor for each day of year
Plot of cumulative Frequency distribution @ each receptor
Critical day Source/Receptor Selection
MET DATA
RAM
Critical source/receptor contribution tables for 24 hr. & 3 hr. avg.
1
Design Emission Inventory

ISOLATED POWER PLANT
ANALYSIS
FIGURE 2

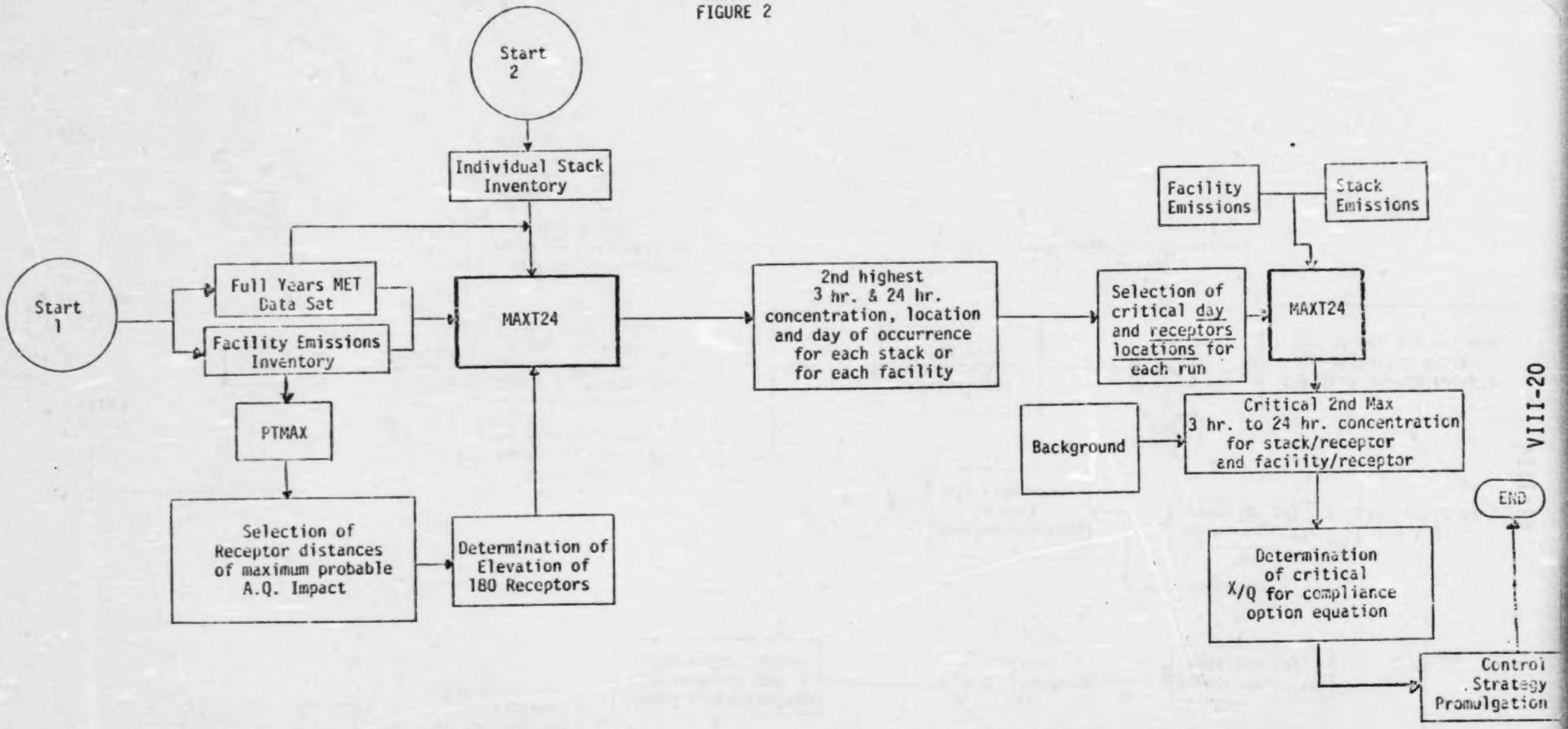
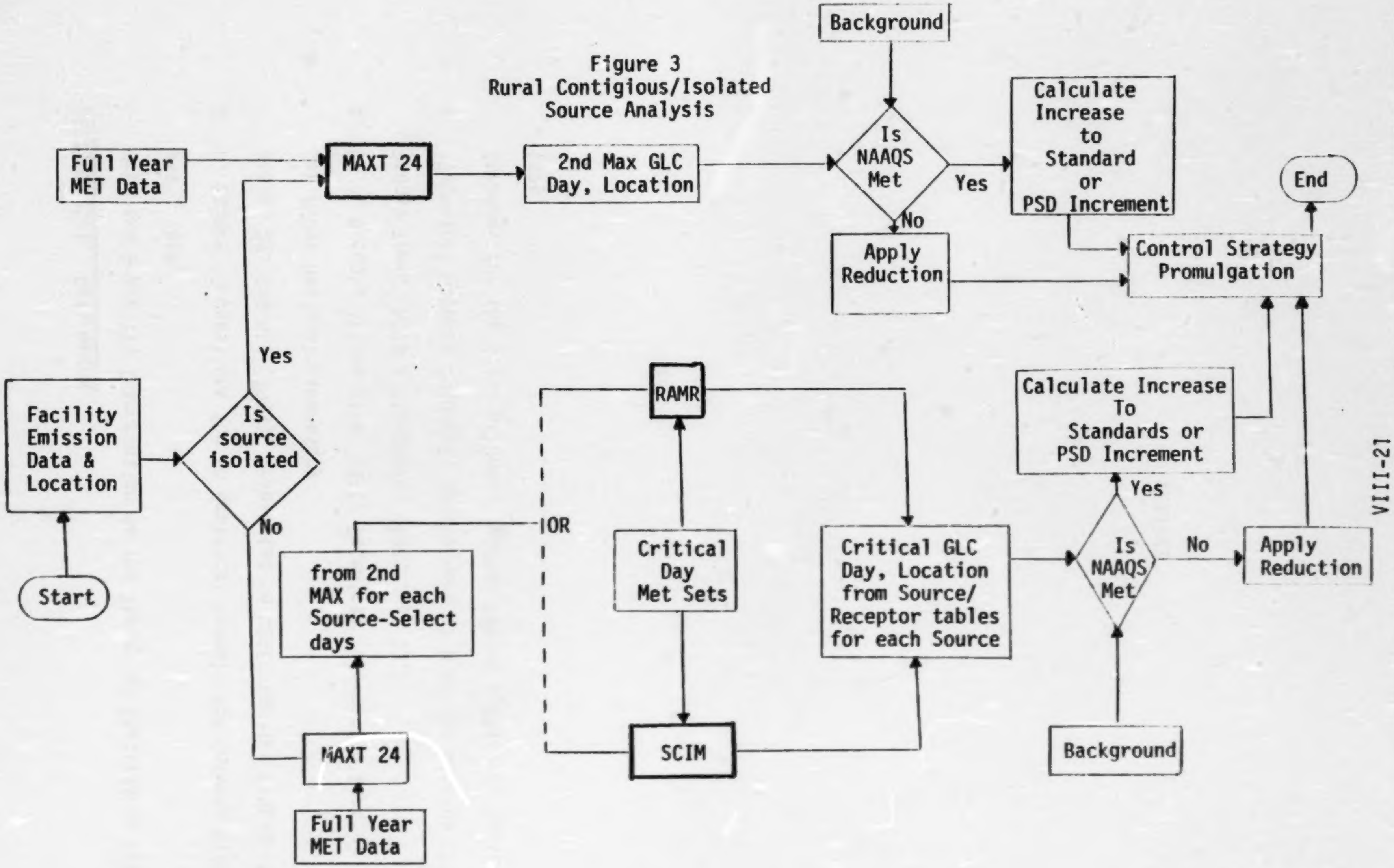

Start 2
Individual Stack Inventory
Start 1
Full Years MET Data Set
Facility Emissions Inventory
MAXT24
PTMAX
Selection of Receptor distances of maximum probable A.Q. Impact
Determination of Elevation of 180 Receptors
2nd highest 3 hr. & 24 hr. concentration, location and day of occurrence for each stack or for each facility
Selection of critical day and receptors locations for each run
Facility Emissions
Stack Emissions
MAXT24
Background
Critical 2nd Max 3 hr. to 24 hr. concentration for stack/receptor and facility/receptor
Determination of critical X/Q for compliance option equation
Control Strategy Promulgation
END

Figure 3
Rural Contigious/Isolated
Source Analysis


Start
Facility Emission Data & Location
Is source isolated
Yes
No
Full Year MET Data
MAXT 24
2nd Max GLC Day, Location
Background
Is NAAQS Met
Yes
No
Calculate Increase to Standard or PSD Increment
Apply Reduction
Control Strategy Promulgation
End
MAXT 24
Full Year MET Data
from 2nd MAX for each Source-Select days
OR
RAMR
Critical Day Met Sets
SCIM
Critical GLC Day, Location from Source/ Receptor tables for each Source
Is NAAQS Met
Yes
No
Calculate Increase To Standards or PSD Increment
Apply Reduction
Background

SECTION VIII. References

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3. G. A. Briggs, 'Plume Rise' USAEC Technical Information Center, Oak Ridge, Tenn. NTIS # TIO-25075, (1969). p. 23.
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SECTION IX

DESCRIPTION OF AIR QUALITY MODELS

SECTION IX. DESCRIPTION OF AIR QUALITY MODELS

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SECTION IX. DESCRIPTION OF AIR QUALITY MODELS

INTRODUCTION

The purpose of this Section is to outline the theoretical assumptions and mathematical structure of the models utilized in the rulemaking process. New analytical tools not used in the proposal analysis, such as RAM and SCIM are briefly described for the general reader with theoretical and mathematical details referenced for those who are interested. The MAX24 model and the CSFP program were modified for proper evaluation and refinement of the final strategy. Descriptions of these modifications along with those portions described in the original Technical Support Document (TSD)(1) are also included. A modified rollback approach for handling individual source category emission reductions is reviewed. For completeness, the descriptions of CDM incorporated in the proposal TSD with minor clarifying revisions are also included.

A. Multiple Source Air Quality Diffusion Models

1. The Climatological Dispersion Model (CDM)

As mentioned in the TSD for the proposed regulations of November 10, 1975, the Climatological Dispersion Model computer code(2) was developed by the Environmental Applications Branch, Meteorology Laboratory, USEPA at Research Triangle Park, North Carolina. The model was developed for estimating long-term arithmetic average concentrations from multiple-sources in urban surroundings. The description contained in this subsection is essentially the same as that contained in the proposal TSD.

However, some clarifying revisions have been included in portions of the write up that were questioned in the public comment.

The CDM describes the spreading of a plume as it is transported downwind from a continuously emitting source. The effects on each identified receptor for the observed combination of wind direction, wind speed, and atmospheric stability are calculated with the aid of a high speed computer. The relative frequency of occurrence of each such meteorological combination is then used to weigh the calculated concentrations. The resulting weighted concentrations are summed over all meteorological conditions and all sources. The plume is assumed to have a Gaussian distribution in the vertical direction and a uniform distribution in the horizontal direction. The resulting mathematical expression for calculating point and area source contributions to each receptor is an unvariant Gaussian (in the vertical only) equation.

Hourly meteorological data (for a season or year) are used to determine a joint frequency distribution of meteorological conditions. Within the CDM, wind speeds are grouped into six clases, wind directions into 16 classes, and atmospheric stability into 6 classes, yielding 576 possible conditions. The atmospheric stability classes are defined by the objective criteria of Pasquill as modified by Turner (1964)(3) (numbered in order of increasing stability). This method requires no upper air (sounding) data. Surface data at airports is supplemented with solar insolation(cloud cover) and elevation (latitude, time of day, etc.) data. The atmospheric stability classifications were slightly modified by separating Pasquill-Gifford stability class 4 into two separate classes - 4 (neutral daytime conditions) and 5 (neutral nighttime conditions). Stability class 6 is a combination of Pasquill-Gifford classes 5 and 6. The National Climatic Center version (day/night) of the Star program(4) was used to process and properly format the above meteorological data to give the joint frequency of occurrence of the three meteorological parameters.

In an urban area the program accounts for the thermal heating influences from traffic, buildings, etc. by a stability class decrease of one (to a more unstable class) for neutral and unstable stability classes (with the exception of class 1 which was unaltered) for the calculation of area source concentrations. Stable classes 5 and 6 (ground base nighttime inversions) are classified as neutral conditions for both point and area sources. Neutral and unstable classes for point sources are left unchanged in the program.

A second urban stability correction was based on the findings of Pooler (1966)(5), who found that for low-level releases (source height of 50m or less) of a tracer in an urban area, the dispersion coefficient [$\sigma z(x,Pm)$] is better approximated if an initial value (σ_o) (value at source) of approximately 30 meters is used. The value of the initial (σ) for point sources is decreased linearly to zero for physical stack heights between 20m and 50m. The mathematical standard derivation of vertical dispersion for point sources used in the model becomes:

$$\sigma_z(x, P_m) = a x^b + \sigma_{zo}(h) \qquad (1)$$

where:

$$\sigma_{zo} = \begin{cases} \sigma_o(h) & \text{for } h \leq 20m \\ 50-h & \text{for } 20m \leq h \leq 50m \\ 0 & \text{for } h > 50m \end{cases}$$

h = source height in meters (m)

$\sigma_o(h)$ = initial dispersion coefficient (m)

x = distance downwind from source (m)

P_m = stability class ($m=1-6$)

a,b = empirical constants dependent on stabilities and diffusion time

For area source emissions, CDM allows for the input of an initial dispersion value ($\sigma_o(h)$) for each stability class, to account for dispersion in urban areas of different roughness characteristics. In the urban areas of Cleveland, Toledo, and Akron, $\sigma(h)$ of 30(m), 15(m) and 10(m) were chosen to reflect urban roughness as a function of population and industrialization. Bowne gives further discussion on diffusion rates for urban and suburban areas based on data gathered since 1963.(6)

The above adjustment for low level point sources and area sources gives a good approximation of the effects of urban roughness on pollutant dispersion.

Two options are incorporated in CDM for estimation of plume rise. The first utilizes Briggs "2/3 Power Law" for buoyancy (dominated rise in an unstratified atmosphere or in a slightly stratified atmosphere in the early part of plume rise). Separate expressions for before final plume rise (i.e. bent over plume) and after final rise using empirical data from plume observations are given in the CDM user's guide. These expressions are assumed to hold for unstable, neutral and stable atmospheric conditions. The second option permits the user to calculate plume rise by Holland's equation.

To account for the increase in wind speed with height above the ground, the model estimated the wind speed at the stack top through a power relation based on the research of DeMarrais[7] in an area of level terrain. The expression for calculating stack top wind speed is as follows:

$$\bar{U}_{st} = \bar{u}\,(h_s / Z_m)^p \qquad (2)$$

where $\bar{u}$ = mean wind speed measured from a ground-level surface wind instrument (central wind speed values are used in CDM and are given according to wind speed class in Table 2 of the CDM user's guide. The wind speed classes are specified by the joint meteorological frequency function).

h_s (m) = physical height of stack above ground

p = empirical constant determined by DeMarrais which depends on stability class (value given in Table 3 of CDM user's guide)

Zm = 10m, approximate height of most weather wind speed instruments.

The procedures for accounting for this high variability of atmospheric mixing depths seasonally, daily and diurnally can be found in papers by Calder[8], and Martin and Tikvart.[9] (Table 4 in the CDM user's guide gives the CDM-assigned mixing height for each stability class).

Atmospheric removal processes for SO_2 such as oxidation, absorption, washout, etc., are approximated in the model by an exponential decay term. The removal processes are characterized by specifying an SO_2 half-life. Due to the limited data and wide variety of removal processes which may be operating, it is difficult to define an absolute value for SO_2 half-life. General conclusions from evidence derived from past atmospheric and laboratory experiments show that the SO_2 half-life under variously defined atmospheric conditions can range from ten's of minutes to several days, with several hours being the preferred range under many urban conditions. A value of four hours has been used in many previous studies (i.e.; Turner (64))[3] and was also utilized in the Ohio SO_2 strategy development study.

For a specific source-receptor configuration, the CDM estimates the concentration by finding the wind direction sector which contains the line connecting the source-receptor pair and solving the appropriate equation for all wind speeds and stability classes. The long-term average concentration, C, is obtained by summing all concentrations and weighing each one according to the frequency of occurrence of the particular wind direction, wind speed, and stability class.

The long-term average concentration at each receptor due to point sources is obtained through the following general expression:(2)

$$\bar{C}_p = \frac{16}{2\pi} \sum_{n=1}^{N} \sum_{n=1}^{6} \sum_{n=1}^{6} \frac{G_n \, \phi(k_n, l, m) \, S(X_n, Z; \bar{U}_{sT}, P_m)}{X_n} \qquad (3)$$

The sum in equation (3), over all combinations of wind speed and stability categories for each source receptor pair would involve 6 x 6 = 36 terms. The total number of terms summed would equal N x 36 where N = number of point sources.

Multiple angular integration using the trapezoidal rule is carried out over the grided region to determine concentrations due to area source emissions. These estimated concentrations are calculated by the following expression.(1)

$$\bar{C}_A = \frac{16}{2\pi} \int_{0}^{\infty} \left[\sum_{R=1}^{16} q_{kn}(x) \sum_{P=1}^{6} \sum_{M=1}^{6} \phi(k, l, m) \, \hat{S}(x, Z; \bar{U}_{sT} P_m) \right] dx \qquad (4)$$

The effective height of the area source distribution can be regarded as constant over the entire area. An average value of total area source strength for each of 16 sectors is computed by the integral procedure where the limits of integration are dependent on the size of the grided region. Similar to the point source concentrations all combinations of wind speed and stability are summed (for each wind direction sector 22-1/2 degrees in width) and weighed with the joint frequency function.

The total average annual concentration due to point and area sources at each receptor is thus given by:

$$\bar{C}_T = \bar{C}_P + \bar{C}_A$$

where the variables - equations (3) and (4) are defined as:

S = the atmospheric dispersion function whose form is dependent on whether the mixing layer aloft (stable layer of air) is affecting the plume distribution. The same function is used for point source and area sources with the exception that power law wind speed for calculating plume rise is used for point sources only (Function is given below in equations 5 and 6).

ϕ = (k,1,m) - the joint frequencies of occurrence of wind speed, wind direction and stability expressed as a decimal fraction from 0.0 -1.0 (0-100% freq. of occurrence for the time period under consideration one year normally or seasonal).

k = wind direction sector index (1-16)
kn = wind direction sector index appropriate to nth point source
ℓ = wind speed class index (1-6)
m = day/night revised Pasquill stability class index (1-6)
x = radial distance from receptor to infinitesimal area source
xn = radial distance from receptor to the nth point source
z = elevation of receptor above ground (z=0 for ground concentrations)
Pm = day/night revised Pasquill stability category
Ul = representative central wind speed class taken from joint frequency function (airport wind measured @ approx. 7-10m off ground)
Gn = emission rate for the nth point source

$q(x) = \int_0^{\theta_R} Q(x,\theta)\,d\theta$ = emission rate for area source in the kth wind sector
$Q_{\theta_R}(x,\theta)$ = = are source strength for sector Angle measured relative to polar coordinate system centered at receptor (k=1-16 making 16 sectors of 22-1/2° intervals, measured clockwise from north as in specifying wind direction).
$\bar{U}_{st}$ = mean wind speed at top of point source stacks given in equation (2).

When an elevated stable layer occurs locally, the estimated pollutant concentration can be calculated with the assumption that all the effluent remains within the mixing depth L, defined as the vertical distance from the ground to the base of the stable layer. If the plume rise from a specific source elevates the plume above the mixing depth, the ground level concentration from that source is taken to be zero. Pollutant dispersion in the vertical is a Gaussian function of downwind distance up to a critical distance were the lid of the mixing layer begins to influence vertical dispersion. The critical distance is assumed to occur when the value of $\sigma_z(X_L) = 0.8L$, where X_L is the distance downwind to the point where the mixing layer begins to influence vertical dispersion. The Air Quality Display Model (AQDM)(10) used Turner's suggestion that the distance X_L can be approximated when ($\sigma_z = .47L$). Limited vertical mixing is assumed when $\sigma_z > .8L$. For the case where the stable layer aloft does not appreciably affect vertical dispersions, plume conning or fanning ($\sigma_z \leq 0.8L$) the dispersion term is given by an unvariant Gaussian expression for ground level concentrations as:

$$S(x,0;\bar{u}_r,P_m) = \frac{2}{\bar{u}_\ell \sigma_z \sqrt{2\pi}} \exp\left\{-1/2\left(\frac{h}{\sigma_z}\right)^2\right\} \exp\left\{-\frac{0.692x}{\bar{u}_\ell T_{1/2}}\right\} \quad (5)$$

When the stable layer aloft begins to offset vertical disperson, plume trappings or fumigation(0.8L), the dispersion term is given by a Box formula expression. Given here for ground level concentrations as:

$$S(x,0;\bar{u}_T,P_m) = \frac{1}{\bar{u}_\ell L} \exp\left\{-\frac{0.692x}{\bar{u}_\ell T_{1/2}}\right\} \quad (6)$$

where:

(X,Pm) = vertical dispersion coefficient - the vertical standard deviation of the Gaussian concentration distribution at a distance from the source.

h = effective stack height, sum of plume rise and physical stack height for point sources.

$T_{1/2}$ = SO_2 decay time (hours)

$\bar{u}_L$ = representative ground level wind speed (classes = 1-6)

$\bar{u}_T$ = wind speed at stack top

x = source to receptor distance

Pm = stability class category (m=1-6)

L = mixing height adjusted for stability class (the mean afternoon mixing height is used for stability classes 2,3, and 4, the mean nocturnal mixing height is used for class 5, and one and half times the mean afternoon is used for class 1.)

The exponential terms exp(-a) where (a) is the parameters and constants in the parenthesis can be expressed as ($\frac{1}{2.718}$)^a (Note: the exp$\left\{-bz^2\right\}$ is a Gaussian distribution in Z, hence the often quoted name of the expression in equation (5)).

The second exponential in equation (5) and the exponential in equation (6) is the SO_2 decay term.

Some useful external output features of CDM include options for calibration, pollution roses for selected receptors, English or Metric unit input, Larson's statistical transformations and an individual source contribution table. The last three options were program modifications made to the original CDM, which basically involved incorporation of existing AQDM subroutines.(11) The two most important features include the calibration and source contribution tables. The calibration option essentially involves the comparison of observed concentrations at those sites. A separate regression analysis is made with this data to calculate the regression coefficients which are used as input to the model for calculating the calibrated concentrations. Specifics on the calibration procedure and the meaning of the results will be given in Section B of this part.

The source contribution table was utilized for evaluating individual source impact on specific receptors for the evaluation of different control strategies. The option exists for 10 maximum receptor locations to be processed or a choice of ten receptors to be input. The source contribution to each receptor is given for each source along with an absolute value in micrograms per cubic meter. The absolute value includes only the uncalibrated concentrations at each receptor but has been adjusted by EPA to include the calibrated values also. The area source contributions are given with respect to 16 compass-oriented sectors centered at each of the 10 user-selected or 10 computer-selected maximum receptors.

The output to the modified version of the CDM program (with all options) consists of calibrated pollutant (up to two) concentrations at each receptor due to point and area sources in micrograms per cubic meter (µg/m), the total calibrated concentrations at each receptor (µg/m), the monitoring site concentrations, the source contribution tables for one or two pollutants, and a statistical data table for Larson's transforms.

CDM has also been coupled to a strategy program for regulating and forecasting emissions. This program is discussed in Part II-A3.

The validation studies conducted on CDM were made with data compiled by Turner and Edmisten (1968) for St. Louis, Missouri which is discussed in Calder's paper(8) and with data collected in 1969 for the New York Air Quality Control Region. The later study(12) was to evaluate the performance of four basic dispersion models and, combinations thereof to include multi-source (point and area) predictions for models designed to estimate only area source contributions. The CDM model received prime emphasis.

Results of the studies show that CDM systematically overcalculates the average concentration values but underestimates these values after the model is calibrated. The overall results of the composite evaluation study (New York data) concluded that CDM gives good estimates of mean and maximum SO_2 concentrations and is preferred over AQDM for control strategy evaluation.

A summary of the basic mathematical assumptions inherent to this model and in general of all Gaussian models are listed in Subsection E of this Section.

SECTION IX. A. 1

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2. Realtime Air Quality Simulation Model (RAM)

This subsection is not intended to give a detailed description of the mathematical algorithms contained in RAM but to briefly describe the model's major features and capabilities that necessitated its use in the rulemaking process. A full description of RAM is given in Turner and Novak (1976).(1)

RAM is the three letter designation for an efficient Gaussian-plume multiple-source air quality algorithm. RAM, a method of estimating short-term dispersion using the Gaussian steady-state model, can be used to estimate air quality concentrations of nonreactive pollutants for averaging times from an hour to a day. The basic input data consists of hourly meteorological data, including wind direction, wind speed, stability class and mixing height; emission inventory data for point and area sources; and various analytical and control option selectors. A useful and important feature of the model allows the choice of three receptor location scenarios. This allows for the analysis of the maximum air quality impact of specific significant point and area sources or the total impact from groups of contigious point or area sources. The model also allows for air quality predictions at specified receptors such as ambient air monitoring sites.

Four versions of the RAM model were utilized in the rulemaking process. Two of the versions, normal RAM (original model version) for selected day analysis and RAMF for the analysis of a full year of data, have dispersion parameters (σ)

representative of urban areas. These σ's are based upon the tracer experiments performed in St. Louis and reported by McElroy and Pooler.(2) The tracer data is represented by the interpolation formulas of Briggs reported in Gifford (1976).(3) The σ's are functions of distance between source and receptor, and of atmospheric stability class as specified by urban conditions. The other two versions, RAMR for rural selected day analysis and RAMFR for the analysis of a full year of data, have the dispersion parameter values of Pasquill-Gifford for rural dispersion.

The similarity and differences of the four versions of RAM can be expressed by a 2 by 2 matrix.

	NORMAL RAM	FREQUENCY DISTRIBUTION RAM
URBAN σ's	RAM	RAMF
RURAL σ's	RAMR	RAMFR

The normal RAM (RAM and RAMR) is intended for application to one or several consecutive days but not for longer periods of record. The frequency distribution versions (RAMF and RAMFR) calculate 24-hour concentrations over a period of record up to one year in order to enable the user to look at estimated frequency distributions of 24-hour concentrations over that interval at a limited number of receptors. No more than 39 receptors can be used with these versions of RAM. Computations are performed serially for each 24-hours and a disk record of

24-hour concentrations is written at the end of each simulated day. Within each 24-hour period estimates are made hour-by-hour.

Besides the four programs mentioned, there are 3 additional programs related to RAM that manipulate input data and output results. Two of these programs are for the purpose of processing the input data. The RAMMET program is similar to the MAXT24 preprocesser program which assembles the meteorological data in a proper format for input to the main program. RAMQ like RAMMET is a preprocesser but handles emission inventory data instead of meteorological data. The third program (CUMF) determines cumulative frequency distributions for each receptor location and utilizes a Cal-Comp plotter to produce cumulative frequency plots of estimated concentrations.

All the main program versions mentioned thus far use the same Briggs plume rise equations as CDM and MAXT24. There is no inclusion of possible building effects or stack effects due to aerodynamic down-wash (as for all models utilized in the rulemaking). The same power law expressions utilized in CDM and MAXT24 are used in RAM to adjust (increase) wind speed with height.

The effects due to eddy reflection at a stable layer aloft are considered mathematically as a sudden transition which is not likely to occur in the real atmosphere. If the effective plume height is calculated to be below the mixing height (even if only a slight distance below), the plume is assumed to undergo complete eddy reflection at the barrier. If the effective plume height is calculated above the mixing height, the entire plume is assumed to be stabilized within the stable layer and is calculated to contribute nothing to ground level concentrations. In the actual atmosphere when the plume is in the vicinity of the mixing height with the plume centerline either above or below, a portion of the plume is probably stabilized above the mixing height and a portion of the eddy is reflected downward. The MAXT24 model contains the same assumptions.

The algorithm also assumes eddy reflection at the ground regardless of stability and at a barrier at the level of the mixing height for unstable and neutral conditions. If there is any retention at the surface due to either physical removal or chemical reaction, RAM will tend to overestimate concentrations. Loss of SO_2 due to reactions so that it can no longer be measured as SO_2 is incorporated into RAM as an exponential loss with a single half-life, for the entire period of record to be processed. The half-life is read in as an input variable. This assumes the loss of SO_2 as a function of the travel time from source to receptor.

Topographic influences, except as reflected in the meteorological data used as input, are not included in the algorithm. RAM assumes that sources and receptors are on a flat plane or possibly gently rolling terrain.

A meteorological effect that is not being considered in RAM is that of fumigation, either lake effect or inversion breakup fumigation. The algorithm assumes a series of independent steady-state conditions and cannot consider the transitional effects of fumigation.

One of the potential uses of applying the frequency distribution versions (RAMF or RAMFR) is to examine periods of high calculated concentrations. If such a period is associated with light winds and wide shifts in wind direction, the user should be very cautious in the use of the resulting concentrations. Under such conditions the meandering polluted air may return over a number of sources after having already received a dose of pollutants while flowing in another direction. Since RAM does not consider trajectories of the air motion, these effects are not considered and it is likely that the algorithm will underestimate concentrations under this condition.

It should also be kept in mind in trying to estimate maximum concentrations, that whatever the number of receptor locations, this represents a small sample of the horizontal plane and there are other possible locations that may have higher concentration. This is an additional reason that may cause RAM to underestimate the highest concentrations.

A summary of the basic mathematical assumptions inherent to this model and in general of all Gaussian models are listed in Subsection E of this Section.

SECTION IX. A. 2

References

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3. SAMPLED CHRONOLOGICAL INPUT MODEL (SCIM)

This subsection is intended to give a brief description of the basic characteristics and capabilities of the SCIM model. A more detailed description of the mathematical assumptions and theory can be found elsewhere.(1)

As for all models mentioned thus far, SCIM is also a Gaussian plume model. Like RAMR and RAMFR, SCIM is a multiple-source (point and area) dispersion model applicable to rural surroundings.

SCIM has been modified to accept basically the same meteorological input data as does the RAM and the Single Source Model (MAXT24, described in Section IX. B. 1). It also accounts for terrain difference in a way similar to MAXT24. Outputs are 24-hour concentrations at specified receptor sites for specified days; with source contributions for selected receptors where required.

A number of modifications were made to SCIM to correct fortran coding deficiencies of the original model version and to make concentration estimates as compatible as possible with those of the MAXT24 model. Comparisons between the two models indicate that SCIM concentration estimates are generally within 10 percent of the MAXT24 estimates. A similar comparison of RAM and MAXT24 was made showing comparable results.

A summary of the modifications made to the original SCIM follows:

1. An error which existed in the original SCIM subroutine which calculates σ_z for the rural case was corrected. The subroutine calculates σ_z by the equation $\sigma_z = a_i x^p$. The subroutine was selecting the wrong coefficients for the equation.

2. SCIM precalculates σ_y and σ_z values for a series of distances used in the finite difference integration scheme for area sources. The point source calculation procedure uses σ_y and σ_z values interpolated between the present values where it is convenient in order to save computer time. Unfortunately, no allowance was made in SCIM for cases where no precalculated and present values were used. Changes necessary to allow for this situation were made.

3. The original SCIM computed concentrations due to limited mixing by merely substituting the mixing height, L, for σ_z in the dispersion equation. Thus, the limited mixing equation was as follows:

$$\chi = \frac{Q}{\pi \sigma_y L \bar{u}} \exp\left\{-\frac{1}{2}\left(\frac{H^2}{L^2}\right)\right\} \exp\left\{-\frac{1}{2}\left(\frac{y^2}{\sigma_y^2}\right)\right\}$$

This was corrected by substituting the procedure used in the Single Source (CRSTER) model.

4. The original SCIM calculates concentrations due to a source as long as the plume height does not exceed the mixing height by more than half the plume rise. For example, if the stack is 100 m, the plume rise 400 meters, and the mixing height 305 meters, the concentration would be calculated by the usual

equation. The program was changed to compute concentrations only when the plume height is less than mixing height.

5. The original SCIM used an older plume rise equation published by Briggs. This was corrected by substituting D. B. Turner's plume rise subroutine which is used in the UNAMAP models.

6. The calculations of σ_y in the old SCIM differ from the σ_y values used in the Single Source Model by about 10 percent or so. B. Turner's routine, as used in the UNAMAP models, was substituted.

7. The original SCIM uses the power law equation to scale the reported wind speed to stack height. This is used to calculate plume rise. SCIM then scales the wind speed to plume height for use in the dispersion equation. The use of two different wind speeds in the dispersion calculation is undesirable. SCIM was changed to always scale the wind to stack height, as is done in the Single Source Model.

A summary of the basic mathematical assumptions inherent to this model and in general of all Gaussian models are listed in Subsection E of this Section.

SECTION IX, A.3

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B. Single Point Source Models

1. Single Point Source Second Maximum 24-hour Dispersion Model (with terrain adjustments) (MAXT24) (CRSTER) and The Point of Maximum Concentration Model (PTMAX)

Two point source diffusion models were used in the analysis of isolated facilities for the attainment of the short-term air quality standard in rural areas. These include MAXT24, and PTMAX. A brief description of the capabilities, limitations, and mathematical assumptions in each of these models follows.

The MAXT24 (CRSTER)(1) model is designed to estimate SO_2 concentrations due to point sources at a single location for averaging times of 1 hour, 24 hours and 1 year, with emphasis on the maximum 24-hour values. The model was developed by the Meteorological Division of the Environmental Protection Agency. It utilizes a Gaussian plume formula and assumes vertical and horizontal dispersion determined by coefficients based on Pasquill-Gifford stability classification. Concentrations are estimated for each hour of the year, (from which the annual and 24-hour concentrations are calculated), based on wind direction, wind speed, mixing height and stability. Plume rise is calculated from Brigg's formulation.

The Pasquill stability class is determined from standard NOAA hourly weather records using the objective scheme of Turner (1964).(2) The mixing layer height data must be derived from twice daily upper air observations. Hourly surface meteorological data used for stability classification and model input includes wind direction, wind speed, total cloud cover and air temperature. Both upper air (mixing height) and surface data are processed in a program (preprocessor program) which determines the format of the meteorological data needed for each hour by MAXT24's main program. Hourly mixing heights are estimated by the preprocesser with an objective interpolation scheme. The model is capable of estimating the effects on mixing height due to rural or urban surroundings. In the urban case, only the first five stability classes (the most stable class is assumed not to occur in urban surroundings) are utilized while the rural application uses all of the stability classifications. For both cases the plume is assumed to remain elevated for Turner's stability class 7. The user has the option of specifying the urban or rural case. This program also screens all data for completeness, determines the hourly stability classifications and interpolates the twice daily mixing height data (upper air weather stations take soundings twice daily) to hourly values.

Besides meteorological data the MAXT24 model requires source input data. This data includes emission rate (in grams per second), stack height (in meters), stack exit velocity (in meters/seconds) and stack gas temperature (in degrees Kelvin). Monthly or seasonal variations of the emission rate are allowed. In order to predict maximum ground level concentrations, the model has to be told where the maximum value is most likely to occur. The model requires five predetermined distances (receptor-rings) at which concentrations will be calculated. A grid work of receptor locations are defined by the model (from these ranges) in terms of 36 angular directions of 10° intervals. A network of 180 receptors spaced along 36 radials by the 5 predetermined distances results.

To assist in determining the five downwind receptor-ring distances at which concentrations are estimated, the computer program PTMAX(3) is used. PTMAX employs a simple Gaussian dispersion equation to estimate the downwind distance and the magnitude of maximum short-term concentrations for a variety of stability classes. For each plant considered, the downwind distances identified by PTMAX for Pasquill stability classes A - D, in addition to user experience, are used in selecting the five distances at which maximum 3-hour and 24-hour concentrations are likely to occur. For sources with multiple stacks, separate runs should be made for stacks of different physical characteristics (height, exit velocity, etc.). For stacks of the same physical characteristics but different emission rates, the stack with the largest emission rate should be used. After critical stacks (causing the maximum ground concentration) are chosen from the PTMAX analysis, five distances determined from the maximum concentrations occurring under unstable conditions from all of the stacks modeled are selected. These five distances are the ranges to be inputted to the MAXT24 model. From these 180 receptor points a total of 1,576,750 (180 x 8760) separate hourly SO_2 calculations are made for each MAXT24 run.

To simulate the effect of elevated terrain in the vicinity of certain plant sites, the model employs a procedure which adjusts (decreases) the effective height of the plant stacks by an amount equal to the difference in elevation between the plant site and the terrain at each receptor site. To minimize the possibility of significantly overestimating concentrations, the terrain heights considered cannot exceed the stack height. The terrain elevations at each receptor site around the plant are determined from the U.S. Geological Survey (U.S.G.S.) guadrangle maps and are inputted to the model. To accommodate individual receptor elevation adjustments the MAX24 model was modified to accept each receptor elevation and the base elevation of the source.

Plume rise is calculated using the same Brigg's expressions that CDM used for the unstable and neutral stability classifications. For the stable classification, MAXT24 utilizes an expression suggested by Briggs which gives substantially better agreement with observations than other formulas test for stability limited rise. The formula used in MAXT24 for calculating stable condition buoyancy dominated plume rise is:

$$\Delta h = 2.4\, F^{1/3} (\bar{u} s)^{-1/3} \qquad (1)$$

$$\text{or} \quad \Delta h = 5.0\, F^{1/3} S^{-3/8} \qquad (2)$$

whichever gives the smallest rise.(4-5).

Where:

$$F = \frac{g V_s D^2}{4}\left(\frac{T_s - T}{T_s}\right) \text{ ; } F = \text{buoyancy flux parmeter, } (m^4/sec^3)$$

g = acceleration due to gravity, m/sec^3

V = stack gas exit velocity, m/sec

D = Inside stack diameter as measures from stack top, m

T = Stack gas temperature, oK

T = Ambient air temperature, oK

$\bar{u}$ = mean wind speed at stack top, m/sec

s = stability parameter based on vertical potential temperature gradient and absolute ambient temperature, sec^{-1}

(Note: The mean wind speed at the top of the stack is calculated by the same power law expression used in CDM.)

The concentrations that are calculated by MAXT24 assume that emissions and meteorological parameters are fixed for one hour periods. A new set of meteorological parameters is used for each hour of the year. As previously mentioned twenty-four one hour averages are averaged to determine daily mean concentrations from which the maximum 24-hour average concentration is chosen and the daily means are averaged to determine annual means. The Gaussian expression used to calculate the one-hour ground level concentrations is:

$$\chi(x,y,0;h) = \frac{Q}{2\pi\sigma_y\sigma_z\bar{u}}\left[\exp\left\{-0.5\left(\frac{y}{\sigma_y}\right)^2\right\}\right.$$

$$\left.\sum_{n=-\infty}^{\infty}\left(\exp\left\{-0.5(2NL-H)^2/\sigma_z^2\right\}+\exp\left\{-0.5(2NL+H)^2/\sigma_z^2\right\}\right)\right] \quad (3)$$

for $x \leq x_L$; $\sigma_z(x) \leq 1.6L$ when mixing is limited and conditions are unstable or neutral

For stable conditions (unlimited mixing) and $X \leq X_L ; \sigma_z(X) \leq 1.6L$, the reflection terms in equation (3) are not important, and the ground level concentration is expressed as:

$$\chi(x,y,0;h) = \frac{Q}{\pi\sigma_y\sigma_z\bar{u}}\exp\left\{-0.5\left(\frac{y}{\sigma_y}\right)^2\right\}\exp\left\{-0.5\left(\frac{z}{\sigma_z}\right)^2\right\} \quad (4)$$

The summation terms account for multiple eddy reflection of the plume between the mixing layer lid and the ground level. These terms were originally suggested by Bierly, Hewson and Gill (1959)⁽⁶⁾ and Bierly and Hewson (1962)⁽⁷⁾. As the mixing height increases multiple eddy reflection (plume trapping) becomes less and less important in describing plume eddy diffusion. The relatively uncomplicated case of diffusion results and can be expressed by the well-known Pasquill - Gaussian plume diffusion equations. At some distance downwind, the stable layer of air above the mixing height begins to influence the plumes vertical distribution and at twice this distance the plume is assumed to become uniformly mixed in the vertical(8). There is no direct empirical evidence of exactly where downwind of the source uniform vertical plume diffusion begins. This distance (the distance at which σ_z equals some fraction of the mixing height L) is usually defined in terms of mixing height(L) and the vertical dispersion coefficient (σ_z). In general practice this fraction has ranges from 0.47 to 0.80. The CDM model uses 0.8 and MAXT24 uses 1.6.

The equation in MAXT24 to calculate ground level SO_2 concentrations under mixing layer induced uniform vertical plume spread is as follows:

$$\chi(x,y,0;h) = \frac{Q}{\bar{u} L \sigma_y \sqrt{2\pi}} \exp\left\{-0.5\left(y/\sigma_y\right)^2\right\} \qquad 5$$

for $X > 2X_L$; $\sigma_z > 1.6L$ in unstable or neutral conditions.

where:

x = distance downwind from source, (m)

x_L = distance downwind at which vertical dispersion begins to be influenced by the mixing lid, (m)

y = crosswind horizontal distance from plume center line, (m)

Q = source emission rate, (g/sec)

$\bar{u}$ = mean wind speed, (m/sec)

$\sigma_y(x)$, $\sigma_z(x)$ = vertical and horizontal dispersion coefficients, (m)

L = mixing height, (m)

N = typically 3 or 4 to sufficiently include important reflection

h = effective source stack height, (m)

hs = terrain adjusted physical stack height, (m)

Δh = BRIGGS plume rise, (m)

$(h = hs + \Delta h)$

for $h > L$, the plume has penetrated the mixing layer and zero ground level concentration is assumed.

Note: (It is assumed $x = x_L$ at $\sigma_z(x_L) = 1.6L$. The analytical expression from which x is calculated is $\sigma_z(X; P_m) = ax^b$, where a and b are constants dependent on stability class. Turner suggests a linear interpolation at downwind distances between X_L and $2X_L$.)

The basic output of the single point source model has been modified to include the highest of all the predicted second high concentrations of 24-hour and 3 hour averages. The highest and second-highest concentrations for averaging times of 1-hour, 3-hours and 24-hours are also provided for each of the 180 receptor sites. In addition, the 50 highest maximum daily concentration estimates for the whole field of receptor sites are also provided.

The accuracy of the Single Source Model has been reported in the Technical Support Document(9) and in other publication.(10-15) While the accuracy of this model varies somewhat, it is considered to be generally accurate within a factor of two. The model may underestimate or overestimate concentrations for 3-hour and 24-hour concentrations, depending on the individual source and receptor sites considered.

A summary of the basic mathematical assumptions inherent to this model and in general of all Gaussian models are listed in Subsection E of this Section.

SECTION IX B

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C. Modified Rollback Model

Under certain conditions, application of air pollutant dispersion models in urbanized areas cannot be made with reasonable accuracy. More specifically, because of complex geographic parameters (i.e., terrain effects, valley effects), the dispersion models were either not run or run unsuccessfully for certain urban areas. Instead, a proportional model(1) was used to relate changes in emission for future years to changes in air quality. The model handles the effects of growth and controls for individual source categories.

The Modified Rollback Equation is expressed as follows:

$$X_j = B + (X_o - B)\frac{\sum_{i=1}^{n} Q_i G_{ij} F_{i,j} K_i T_{i,j}}{\sum_{i=1}^{n} Q_i K_i}$$

where: X_j = projected air quality concentration for calendar year j,

B = background concentration,

X_o = base year air quality concentration,

Q_i = base year emission inventory for source category i,

$G_{i,j}$ = growth factor for source category i in year j,

$F_{i,j}$ = emission factor ratio for source category in year j,

K_i = emission height factor for source category i,

n = number of source categories,

i = source category index,

j = calendar year index,

$T_{i,j}$ = transportation control factor, if applicable, for source category i in year j.

The modified rollback model does not account for topography, spatial distribution of the pollutant emission sources, or meteorology in the area of consideration. Instead, the model assumes a direct linear relationship between air quality concentrations in excess of background concentrations and pollutant emissions.

The following assumptions are made when applying this model:

(1) the air quality is representative of the study area,

(2) the background concentration due to natural sources does not change,

(3) the meteorology and topography over the study area does not change during the projection period, and

(4) the spatial and temporal distribution of emissions is relatively stable over the projection period.

In order to determine what level of emissions reduction is required from all source categories, the proportional technique was utilized. This is expressed in the equation:

$$R = \left(\frac{A - S}{A - B}\right) \times 100\%$$

where: R = percent reduction required in pollutant emissions

A = projected future air quality concentration in the region under analysis for a given time period (i.e. annual average, second highest 24-hour maximum)

B = estimated pollutant background concentration in the region under analysis for a given time period (i.e. annual, 24-hour)

S = National Ambient Air Quality Standard (80 ug/m³ annual; 365 ug/m³ 24-hour).

Reference for IX.C. Modified Rollback Model

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D. Strategy Model

1. Control Strategy Development Forecasting Program (CSDFP)

The Control Strategy Forecasting Program (CSFP)(1) was utilized in the strategy development for the proposed regulations. The program calculated unregulated and regulated point and/or area source emissions accounting for growth by Standard Industrial Classication (SIC) codes. Three control strategies with various degrees of stringency were incorporated into the model code. The strategies were formulated from various combinations of existing State Implementation Plans (SIPS). As was mentioned in Section VIII of this document, the structure of the CSFP was not suited to developing an evaluation of a regulation with source specific limitations. In order to develop a regulation based on the objective criteria of source air quality impact (as predicted by the air quality modeling) the CSFP had to be modified. A brief description of modifications incorporated in the new program follows.

The new program, now called the Control Strategy Development Forecasting Program (CSDFP), was structured to project unregulated source emissions for the development and testing of sulfur dioxide control strategies. In order to compare projected unregulated and regulated emissions with the National Ambient Air Quality Standards the CSDFP had to be coupled to CDM for evaluation of air quality impact.

The CSDFP program was structured into three stages. The first stage projects unregulated emissions to some forecast or planning year by using the same power law growth equation incorporated in CSFP. Growth rates for point sources can be input according to SIC and can be source specific. If data is available for variable growth rates from year to year or from one political jurisdiction to another it can be input to the program. Emission forecasts for as many as 30 years or as many as 3 political jurisdictions can be made. If point sources are projected to phase out of operation or phase down operations in future years the program can specify the proper adjustments. Projections accounting for new facilities can also be made. Existing facilities are limited in growth to 90% of their rated capacity. Besides the projected emission rates for each source the output of the first stage gives the base year emissions in grams per second and in units of the regulation, the fuel heat generation rates in MMBTU/hour, the rated capacity of each boiler in MMBTU/hour, and the process weight rate for each industrial process in pounds/hour.

The second stage of the program determines source specific emission limits based on the impact of each source and the required emission reduction required to meet the ambient air standards. This output can be used to formulate control strategies to be input to the last stage of the CSDFP. General input variables or coefficients can than be used to apply regulations across 10 broad source categories. If stack specific limitations are required an emission adjustment factor can be input that will override the general categorical regulation. The output of the second and third stage of the CSDFP are essentially the same format as stage 1 with the exception that allowable emissions in grams per second and emission limitations in units of the regulation are given instead of the unregulated projected emissions and the status quo emissions in units of the regulation. The outputs of CSDFP also create a catalogued print file of point and area source emissions formatted for input to CDM. A user's guide listing the required input data for CSDFP is presently being prepared by EPA Region V.

Section IX. D.1.

REFERENCES

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E. Basic Assumptions Inherent to the CDM, RAM, SCIM, and MAXT24 Gaussian Dispersion Models

1. Steady-state conditions - Meteorological conditions for short time period (on the order of one hour) can be regarded as steady state (no time variation in wind and turbulence) and horizontally homogeneous (no space changes in wind flow or turbulence for region being modeled).

2. Vertical mixing is limited by mixing layer (mixing layer reflection is assumed). A boundary layer exists at some height above the ground (mixing heights) that serves as a reflecting medium in unstable or neutral conditions for plumes rising just below the mixing height.

Boundary condition: (Neumann Condition)

$$\frac{\partial \chi}{\partial z} = 0 \Big|_{z=L}$$

Source - Image Reflection Condition

The vertical Gaussian distribution of the plume is assumed up to a critical distance downwind when uniform dispersion begins.

(Note: CDM does not include the mixing layer reflection terms since these terms become relatively unimportant for annual average predictions. All three models assume zero ground concentration for plumes penetrating the mixing layer.)

3. Perfect reflection of plume occurs at the earth's surface. None of the pollutant is lost from the plume to the ground by absorption or any other means.

Boundary condition: (Neumann Condition)

$$\frac{\partial \chi}{\partial z} = 0 \Big|_{z=0}$$

Source-Image
Reflection Condition

4. Mean wind speed exceeds a certain lower limit. Wind circulation is not weak or becalmed. Diffusion in the x direction can then be neglected in comparison with convective transport by the wind.

5. The equation of continuity is satisfied. An inert (no chemical transformation) and passive (no precipitation scavenging) pollutant is assumed. Pollutant decay is accounted for by an exponential decay term.

6. Terrain features do not exhibit marked irregularities in elevation. Gently rolling terrain is acceptable while rough terrain is not. The MAXT24 model can be adjusted for moderately rolling terrain by specifying ground level receptor elevations to adjust the effective plume rise.

7. Although wind direction in the atmosphere undergoes changes with height, the model assumes no change of wind direction with height. Wind shear effects are neglected.

8. Plumes are assumed to be buoyancy dominated. Non-buoyancy dominated or cold plumes can be accounted for by an external input for the CDM model.

9. Individual concentration contributions from sources at a receptor are additive resulting in the total concentration at the receptor. Plume superposition is valid.

10. Plume rise calculations limited to buoyancy dominated plumes for the RAM and MAXT24 models.

11. Effects of extreme wind direction variation within 1 hour time intervals are not accounted for.

12. Buoyancy effects from plume interaction are not accounted for.

13. All sources upwind of a receptor for the hour's meteorological conditions affect that receptor during that hour regardless of the real travel time required to reach that receptor.